Virtual classroom - student and teacher perceptions
Evaluation 2021-2022

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Preamble

In the SURF project 'Education of the Future: Synchronous Online Interdisciplinary Sustainability Education using the Virtual Classroom', the UU-based online facility 'Virtual Classroom' for synchronous online education was tested. The case: a newly developed course 'Inter-University Sustainability Challenge' (IUSC). The IUSC is a bachelor course jointly developed by Utrecht University, Eindhoven University of Technology and Wageningen University & Research, and was run in spring 2021 and 2022.

The virtual classroom was used as the online learning environment for the plenary lectures in the course, that were scheduled once to twice a week over a period of 10 weeks. By using the IUSC course as a testcase, the usability of the virtual classroom for students and teachers could be tested. Researchers observed the sessions in the virtual classroom, and students and teachers were interviewed. This report describes the IUSC course and the virtual classroom, and then summarizes the outcomes of the interviews with teachers and students.

The aim of this document is not to improve the virtual classroom as such. Moreover, this document points out observations and gives recommendations regarding online synchronous education.

1.   **Virtual classroom at Utrecht University**

All IUSC plenary lectures were scheduled in the virtual classroom (from now on called VC) at Utrecht University. The VC enables teachers to teach remotely, from the studio in Utrecht Science Park. During a session, the teacher stands in front of 6 screens (in the second iteration: 8 screens), each with a maximum of 6 remote, visible students (see number 1 in figure 1ᵃ). Below the 6 screens with the students, the VC contains two screens to display the presentations of the teachers or students, and the results of online questions (see arrows numbered 2 in figure 1ᵃ).

Figure 1ᵃ Virtual classroom at UU, in first iteration.

Figure 1ᵇ Virtual classroom at UU, in use for first iteration IUSC.

Some of the characteristics of the VC are quite different from other set-ups for synchronous online teaching. In short, the VC has the following characteristics.

a. 'eye contact'
Each group of up to 6 students, displayed via one of the six students' screens (in iteration 2: eight screens), has its own dedicated camera. When the teacher looks at the group of students, the idea is that they make virtual 'eye contact'. Students can see if the teacher is directly looking into "their" camera/screen. In other set-ups, such as facilities using MS Teams, all students see the teacher through a single camera. In the VC it is possible for the teacher to approach one student group directly by walking up to their screen which makes the interaction livelier and more focused. The teacher can directly engage with a group or individual.

b. Visual and verbal communication
The house rule of the VC is that all students keep their laptop cameras turned on. This increases the "natural" classroom feeling where no one stays invisible. Students can turn their microphones on and off. The studio cameras are turned on continuously and the studio microphone (either lapel, attached to chest, or handheld) is turned on on-demand. Figure 2 shows the VC from the home-screen of the students. The VC student dashboard shows students the 4 or 5 individual fellow-students who have last spoken. In addition, they can see the class, via the classroom view camera in the studio. The students can select multiple views, see section c.
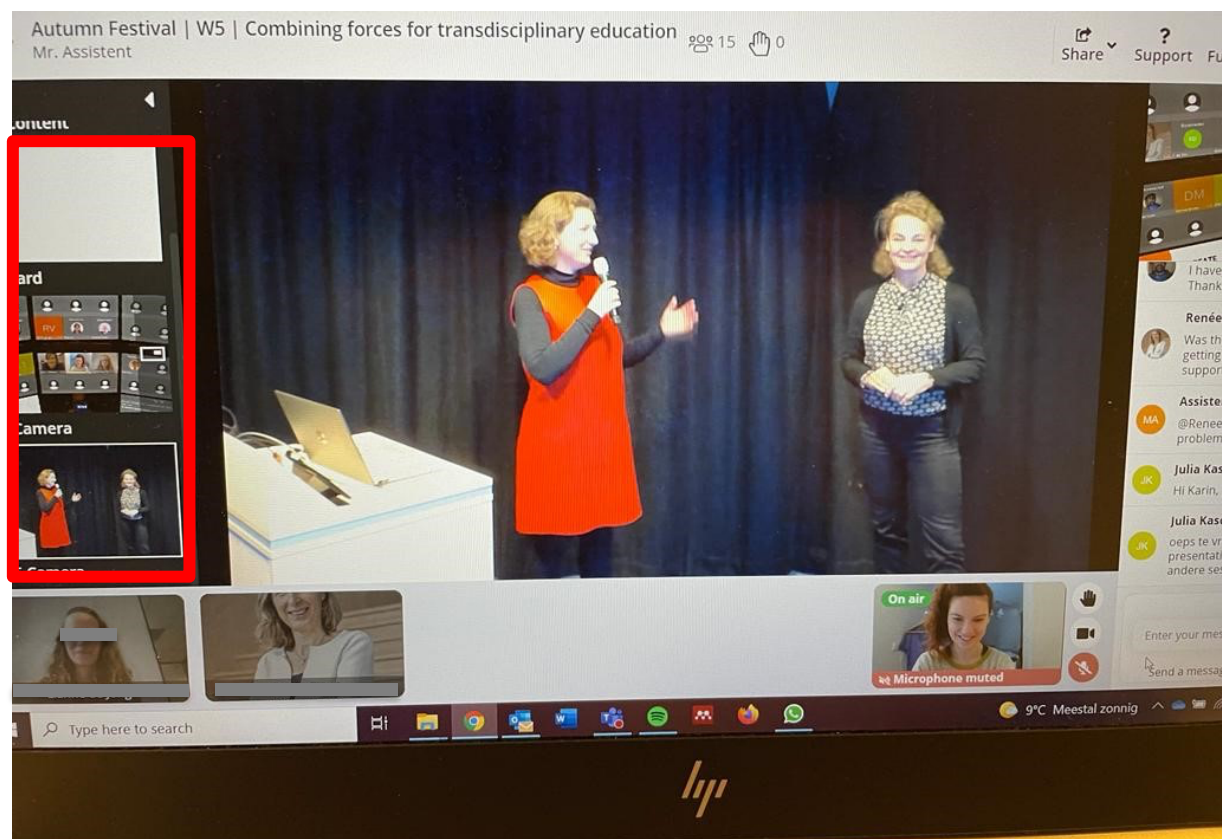

Figure 2 Student's online view of VC, the red box indicating the various screens a student can select

c. Multiple views

During a session, the remote students can use multiple views:
- Front camera view (seeing the teacher from the front looking at the screen),
- Classroom view (from the back of the studio; also seeing screens with all students),
- Presentation by teacher (such as PowerPoint slides or YouTube video),
- Interactive whiteboard,
- Questions for teacher and chats,
- Polls and quizzes.

The students decide which view they select (by clicking on a screen in section a in Figure 2, and thereby enlarging the screen concerned). At any time, each student can decide to select the view of his choice.

If needed, for instance to draw attention, the teacher and moderator have the option to select a specific screen which is then enlarged on the student's laptop.

d. Teacher in natural habitat

In the studio at Utrecht University, where the virtual classroom is located, the teacher is seen in his natural habitat. They stands can walk around to a limited extent, while their students can see them at full-length via their group camera's and, at the same time have a classroom overview, via a camera in the back of the studio.

e. Quizzes and polls

The teacher can utilize quizzes and polls, for:
- both formative and summative assessment (quizzes),
- introducing breaks; online sessions place extra stress on student's attention span. By asking for an answer or opinion, students need to think for themselves, the teacher can pause for a while, talk about the results and then continue.
- quizzes and polls are a starting point for further verbal discussion (Figure 3). After each quiz or poll, the results are shown, both as a graph and on each students' screen (on top of their faces, see Figure 4). So, the teacher can look at a given student and see what they have answered. From there, he can start a discussion ('Jennifer, you answered "agree". Why?')
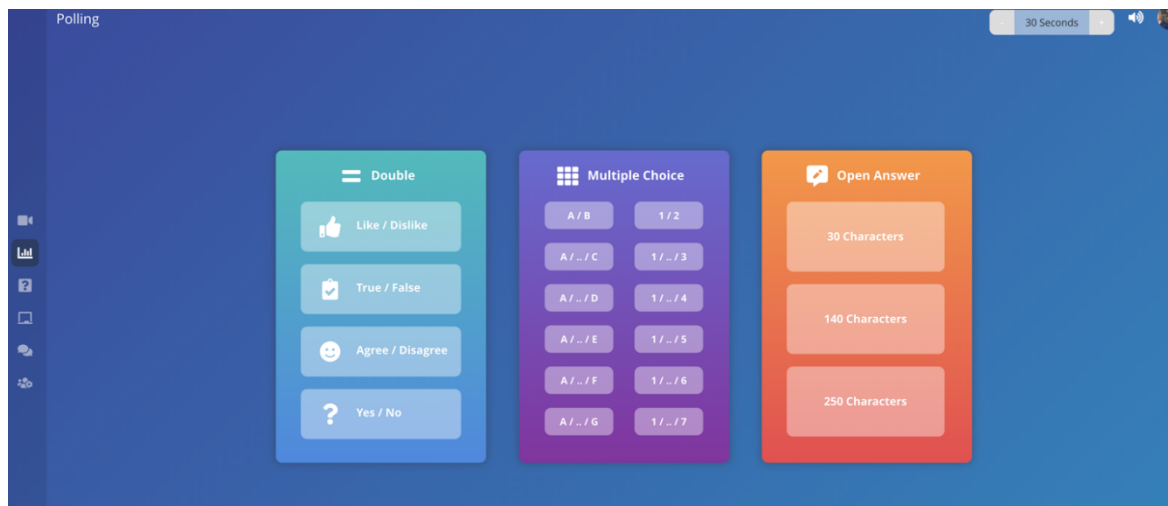

Figure 3 Teacher dashboard to start quizzes and polls

Figure 4 Poll result on student screen

As shown in figure 3, teachers have at their disposal a range of answering options. For polls they can choose options as like/dislike and true/false (blue column). For quizzes there are multiple choice options such as A/B/C or 1/2/3, as well as open questions. For each quiz, the teacher can indicate the time limit for completing the quiz. In figure 3 (top right), the time limit is set at 30 seconds.

As shown in figure 4, after a quiz or poll, the results appear on each of the individual students' screens, enabling the teacher to ask one or two of the students for further explanation. It also allows students to see the responses of their class/teammates.

f. Questions and chat messages
At all times during a session, students can write a remark (chat) or question. Students have the option to post anonymous questions as well. Anonymity only applies to the other students and the teacher during the VC session. After the session, the teacher and VC moderator, a person assisting the teacher, either in the studio or online, can see which student had asked a particular anonymous question.
Each question or chat message can be liked by the students. The teacher can decide to quickly pay attention to questions that have received many likes. Questions of a technical nature can be answered online by the moderator. The teacher can respond verbally.
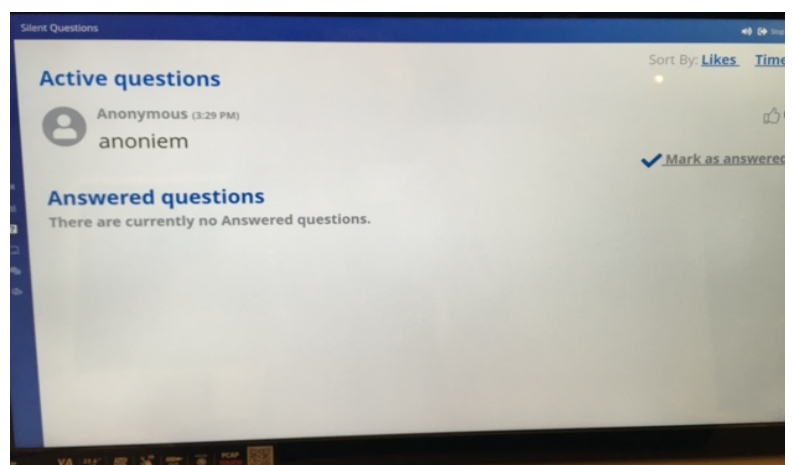

Figure 5 Teacher's question screen

g. Whiteboard
The VC contains an interactive whiteboard. The teacher can use the touch screen for writing or drawing on the whiteboard. He can also give the students access to the whiteboard, allowing students to write or draw as well.
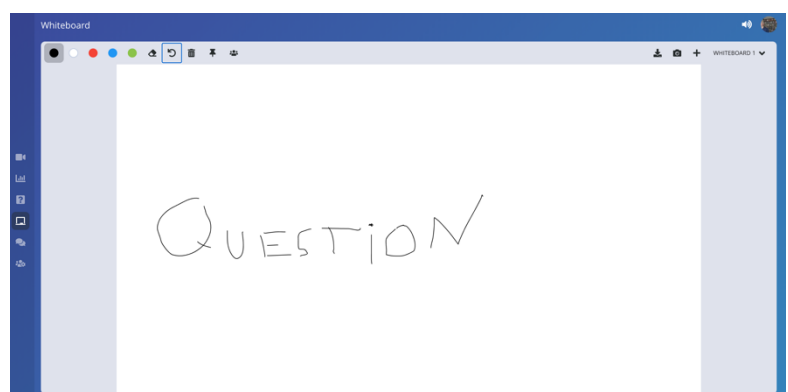

Figure 6 Whiteboard

h. Break-out rooms
Each screen displaying up to 6 students represents a break-out room. In addition, the teacher or moderator can allocate each student to a particular team at the start or during the session; they can do this per screen of six students or he can make teams independent of the location of the students. By clicking a button on the interaction screen, the teacher starts a break-out session. From that moment, students can only see and hear their 5 teammates. In a breakout session students can use the whiteboard and share their screen. A timer in the right corner informs them how much time

Figure 7 Producer display for assigning students to breakout groups

they have in their breakout session. Breakout sessions should start with a clear question or assignment, including instructions for discussion.

i. Moderator / assistant
A moderator can assist the teacher, e.g., by managing and answering questions, introducing a new quiz or poll, etc. The moderator can either be present in the studio (working via a large touch screen) or work online. More than one assistant can login during the session, also online; this person does not need to be physically present in the studio.

j. Session log
After the session, the teacher and moderator can download a log from the website, with data on quizzes, polls, questions posed etc. They can download the log in excel and pdf-format.

Between course iteration 1 and 2, the following changes were made to the virtual classroom:

VC aspect	2021 course (iteration 1)	2022 course (iteration 2)
Maximum number of students attending	36	48
Studio set-up	Recording studio hosting the VC	Studio only used for VC
Front cameras	Tracking cameras only	Tracking cameras + fixed front camera
Breakout rooms	No online teacher access	Online teacher access possible

2.   **Virtual classroom - literature**

In the period 2018-2022, a limited number of articles and reports on the use of the Virtual Classroom / weConnect in educational settings have been published, some also in the context of the COVID pandemic. Most of these studies were carried out by KU Leuven researchers in the period 2018-2020, where the Virtual Classroom was tested and further improved. Most studies focus on synchronous *hybrid* teaching, which is the combination of face-to-face (onsite) with online (remote) teaching in one 'classroom'. This allows the comparison of responses of onsite students with remote students. Although hybrid teaching is not similar to 100% online teaching, some conclusions can be drawn that apply to online teaching as well.

Hybrid synchronous learning
In a 2019 review of synchronous hybrid learning (Raes *et al.*, 2019), the authors find that the online component of hybrid learning has organizational benefits. It allows for higher recruitment rates, and all students can participate regardless of place. And it reduces workload, in the sense that courses do not need to be taught at two different locations. However, it may increase workload relative to a face-to-face only setting: "Both the change in pedagogical methods and the use of technology necessitate more preparation and organisation, resulting in an increased workload." (Raes *et al.*, 2019).
From the pedagogical perspective, the online classroom has the possibility to include expertise from outside and strengthen the willingness of students to make new contacts all over the world.

According to this 2019 review by Raes *et al*., teaching for a hybrid (and consequently also for a fully online) class poses additional challenges; use of this setup requires teachers to adapt their teaching approach. Such a setup "highly influences the pedagogical and learning design and thus it demands other methods of teaching and different activating learning activities." This implies that the teacher or trainer has to adapt his/her teaching approach, but simultaneously has to maintain comparable learning standards.
The review showed that online students perceived more distance and were less engaged than the students that participated face-to-face, the online students had the feeling they watch tv instead of a live lecture. Finally, the technological challenges are very prominent, especially the quality of audio for students participating online.

For future study, the authors listed 5 directions, (1) larger and more diverse sample sizes (numbers of students), (2) more empirical and longitudinal data of the participants, (3) empirical real-time data of the learner experience as engagement and social presence, (4) effects on student learning and student outcomes, and (5) the most scalable approach with regard to technical and pedagogical capacity and limitations.

As a follow-up, the Leuven team carried out a second, literature research during the COVID-19 pandemic (2020-2022), stressing that students at home reported greater difficulty staying task-focused and had less opportunity to interact with their peers. For an engaging and optimal learning experience for both on-site and remote students, careful design is needed (Raes *et al*., 2022a).

Testing the virtual classroom
The Leuven team also tested the weConnect Virtual Classroom set-up themselves, in the Technology-Enhanced Collaborative Learning-project, 2016-2018, (Raes *et al.*, 2022-b). In this project, three different types of technology-enhanced learning spaces were studied, all using a VC setup and the weConnect platform. (1) interactive lectures using quizzes and polls supporting cognitively active learning, (2) collaborative learning spaces with screen-sharing functionalities highlighting the importance of collaboration skills, (3) multi-location learning spaces offering more flexible trajectories to students to connect remotely to the face-to-face classroom (several onsite classrooms connected with one another). The authors conclude in their paper (Raes *et al.*, 2022-b): "After experiencing the technological tools in practice, students' technology acceptance significantly increased. Qualitative results confirm these positive findings." The authors stress "that universities should embrace technology as it gives opportunities for improving interaction, collaboration, and flexibility during learning and instruction."

In more detail, in the virtual classroom, the Leuven researchers investigated relatedness, intrinsic motivation and learning achievement (Raes *et al.*, 2020). Here, they compared 4 situations: (1) all students face-to-face with teacher, (2) all students remote, and a hybrid format where both (3a) face-to-face students and (3b) remote students participated in class. They conclude the hybrid setting is the most challenging one to teach in and to learn in as a remote participant. Remote

students experienced lower relatedness towards the teacher in the fully remote and the hybrid setting. However, according to Raes *et al.* (2020): "with regard to the relatedness to peers, the hybrid-virtual setting is found to be the worst. [] When all students participate virtually, the intrinsic motivation is higher." Especially, technology-enhanced quizzes launched through the platform have been found to positively affect students' motivation in all learning settings.

In a follow-up study in the virtual classroom, the research team distinguished three levels of synchronous learning environments, (1) face-to-face, (2) remote, visible on the screen in the classroom and full interaction possible; (3) remote, following through livestream, students are not visible for the teacher and peers, and students are not able to interact (Raes *et al.*, 2022-c). During lectures, students could choose whether to attend the session face-to-face, remote with interaction, and remote without interaction.
The theoretical framework used is the activity-centered analysis and design (ACAD) framework. Next with focus on presence as well as affective components (student engagement). Moreover, the most prominent determining factors for engagement were the lectures' physical design (or set design) and the epistemic design (task oriented).
In terms of the student perspective, "this study did not find any significant differences between physical and remote presence regarding conceptual understanding, yet significant differences were found in regard of affective engagement in favor of the on-site students and remote students having the opportunity to interact."

In short:
- Use of the Virtual Classroom or similar facilities requires teachers to adapt their teaching approach.
- After experiencing technological tools, students' technology acceptance significantly increased.
- Students' intrinsic motivation in fully online teaching is higher than in hybrid setting.
- Technology-enhanced quizzes launched through the platform positively affect students' motivation.

3.   Case study: the Inter-University Sustainability Challenge

The Inter-University Sustainability Challenge (IUSC) focused on 'Sustainable Cities of the Future'. It is an online and challenge-based course, and requires students to develop an interdisciplinary, sustainable solution. The course ran for 10 weeks from February to April 2021. After a successful first run, the course was revised and repeated in February – April 2022. This time the IUSC course collaborated with the municipality of Almere enabling students to not only acquire and develop interdisciplinary but also transdisciplinary learning experience.
The overall learning objectives of this course are to become familiar with the Sustainability Development Goals (SDGs) from an interdisciplinary perspective and to develop an innovative and scientifically sound solution for the challenge using the interdisciplinary knowledge and skills within their team.

The learning objectives target second- and third-year undergraduates from all disciplines. With the target group and learning objectives in mind, students are supposed to gain the following knowledge and skills in relation to 'Sustainable Cities of the Future':
- Theoretical knowledge about the SDGs,
- Interdisciplinary knowledge and skills,
- Interdisciplinary teamwork,
- Critical thinking, systems thinking,
- Design-based research.

The course content reflects and integrates knowledge from all three universities. Teachers from Wageningen University & Research provided content on air quality, teachers from the Eindhoven University of Technology provided content on energy transition and Utrecht University teachers on urban agriculture. Additionally, guest lecturers from the different universities were invited to introduce and discuss social and ecological urbanism, world views, earth system governance and the IPCC special report on global warming.
The core teaching staff consisted of six teachers – two from each university – who were involved in the course design as well as teaching/coaching. In the second iteration, the core teaching team consisted of 5 teachers and 4 coaches.

The IUSC course provided students with weekly online lectures, workshops and (on demand) coaching sessions, resulting in on average 5 weekly contact hours spread across two to three days a week for a 10-week period. Due to the online setting, the IUSC course integrated several educational technologies. Lectures (online synchronous) were held using the VC while most workshops, tutorials and coaching sessions (online synchronous) were provided through MS Teams, which provided flexible planning for small groups. Brightspace was used as the asynchronous digital learning environment.

In the first course run (2021) students made use of simulation software Tygron Geodesign platform (www.tygron.com/en/) and Minecraft (www.minecraft.net) enabling students to visualize their challenge solutions as 'artefacts'. In both course runs, the Utrecht2040 serious game was used. Through this location based serious game developed at Utrecht University, students were introduced to the sustainability development goals (SDGs) and collaboratively explored sustainable initiatives and possibilities in their city.

In the course design, a challenge-based learning (CBL) approach was followed. At the beginning of the course, students could indicate their preference regarding a topic for their challenge. During the course students, in teams of 4 or 5, explored and analyzed the challenge by using the input from the lectures, workshops and by conducting their own research. By the end of the course, each student team would have developed and presented an interdisciplinary, sustainable challenge solution which was visualized in an online artefact, using visualization software. In a team-based written research report students had to describe their interdisciplinary research process. Figure 8 shows the course overview.
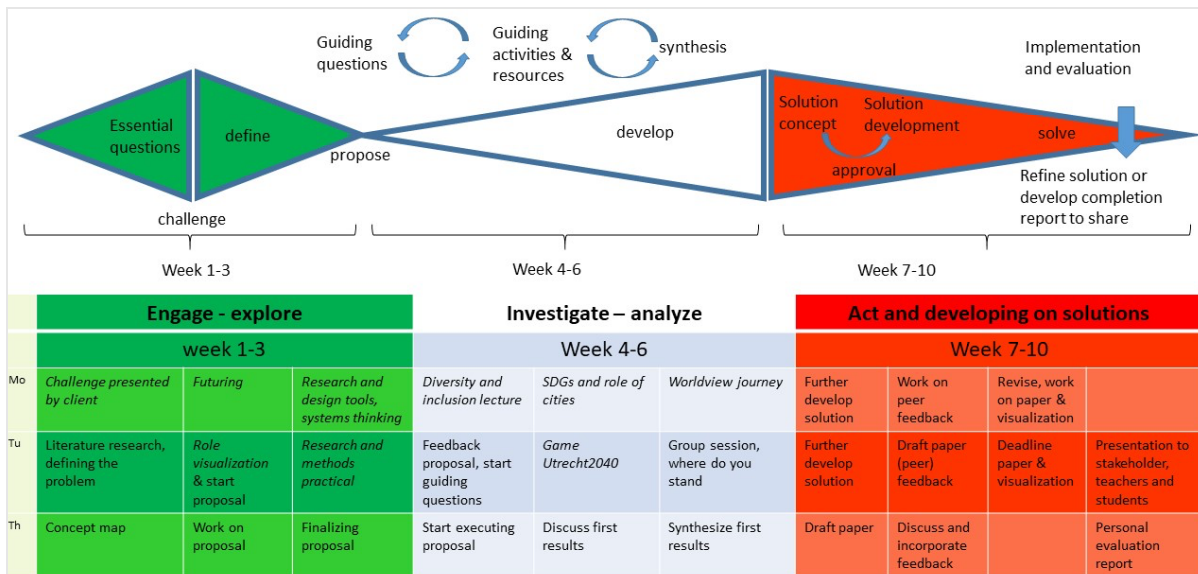
Mo/Tu/Th	Engage - explore			Investigate – analyze			Act and developing on solutions			
	week 1-3			Week 4-6			Week 7-10			
Mo	Challenge presented by client	Futuring	Research and design tools, systems thinking	Diversity and inclusion lecture	SDGs and role of cities	Worldview journey	Further develop solution	Work on peer feedback	Revise, work on paper & visualization	
Tu	Literature research, defining the problem	Role visualization & start proposal	Research and methods practical	Feedback proposal, start guiding questions	Game Utrecht2040	Group session, where do you stand	Further develop solution	Draft paper (peer) feedback	Deadline paper & visualization	Presentation to stakeholder, teachers and students
Th	Concept map	Work on proposal	Finalizing proposal	Start executing proposal	Discuss first results	Synthesize first results	Draft paper	Discuss and incorporate feedback		Personal evaluation report

Figure 8 Structure of the course with the three CBL phases: Engage/explore, investigate/analyze and Act/developing solutions.

The sessions in the virtual classroom (VC) included between 20 and 30 students, from a total of 24 students in 2021 and 37 in 2022. Both course iterations took place during the COVID-19 pandemic. Participating students reported that at the time of the course all or almost all their courses were fully online. Moreover, from iteration 1 to 2, both the set-up and facilities of the virtual classroom and other online platforms had changed substantially. In MS Teams for example, new functionalities were added such as options for displaying more participants (from 9 to 16 to even more), breakout rooms, as well as options for moderation.

4.   **Approach & data collection**

For assessment of the quality of teaching and learning in the VC-online environment, semi-structured interviews with both students and teachers were conducted. The interviews were set up based on the Community of Inquiry-framework. The interviews were also used for evaluating aspects other than the usability of the virtual classroom, such as students' thoughts and ideas of the course in general, the various plenary and coaching sessions, course didactics, student collaboration, and the assignments. For the purpose of this document, only the data concerning the VC are presented.
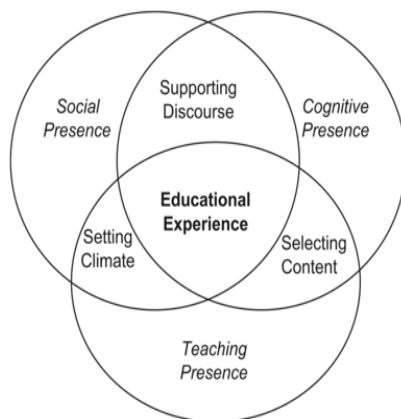
4.1. **Community of Inquiry**

Figure 9: Community of inquiry

According to the Community of Inquiry three overlapping presences are fundamental to deep meaningful collaborative learning (Garrison & Arbaugh, 2007):
Social presence: students experience the presence of their fellow students and are able to interact in a meaningful way.
Teaching presence: students' social and cognitive experience through teaching design and facilitation.
Cognitive presence: students can cognitively engage with the content and construct meaning.

At the intersection of these three presences, deep learning can occur.

Within a 'Community of Inquiry' (CoI) successful collaboration towards a common goal and knowledge construction can take place. Social, teaching and cognitive presence are required for this and should be supported by teachers and through the course design (Garrison, & Cleveland-Innes, 2005).

The literature confirms that interactive synchronous online sessions can support online presence and a sense of community (Martin & Bolliger, 2018). Enhancing personal contact among students as well between students and teachers, for example by addressing individual student responses and offering Q&A sessions, enhances online interactivity and presence. Prompts and guided questions can deepen student learning and are important online teaching strategies. We applied the CoI approach by structuring the interview sections dealing with the VC according to student, teaching and cognitive presence.

4.2. **Data collection**
Student interviews
The students were questioned about a number of aspects, including general impressions of the course, the lectures, coaching sessions, interdisciplinary working and the virtual classroom. In this report, only the answers to the questions about the virtual classroom have been used.

Following course iteration of 2021, a total of 4 students were interviewed once in a focus group. In 2022, a total of 6 students were interviewed 4 times, after 2,4, 6 and 8 weeks in the course. The interviews lasted 1 hour and were carried out online (via MS Teams).

Teacher interviews
Following each course iteration, teachers were interviewed about the course in general (content and didactical approach) as well as the use of the virtual classroom and other online platforms. Following the first iteration, teachers were interviewed individually in MS Teams. After the second iteration the teachers were interviewed collectively, face to face.

Observations
Each virtual classroom session was observed by at least one, and mostly two researchers. Observation notes were used to prepare the interviews with students and teachers.

5.   **Results**

5.1.   **General impressions**
In general, students prefer having face-to-face sessions. However, for inter-university education, an online environment is preferable as it saves travel time. Overall, students were enthusiastic about the virtual classroom. They mention improved natural behavior of the teachers, various viewpoints they can select and the ease of accessing the VC. Moreover, the use of quizzes and polls forces students to think more thoroughly about the content and it helped them to engage online. Break-out rooms are useful for group interaction and bring variety.
The VC is especially suitable for courses where there is lots of discussion and where live synchronous communication as well as interaction is preferred. The benefits and strengths of the VC are less prevalent in sessions where student-teacher and student-student interaction are less dominant.

Quotes by students regarding the VC sessions:
- "A sense of being together."
- "It (the virtual classroom) makes me eager to participate."
- "The first thing I really like is that it is interactive."
- "It makes you more part of the lecture. That already motivates to participate."
- "No need to travel, but with interaction."
- "I am more motivated and pay attention better than in a regular online lecture. Especially because of the quizzes every now and then."
- "The VC is especially suitable for societal kind of courses where you have many discussions."

The VC has room for improvement as well. Students indicate they miss a display on their computer dashboard where all the other students are clearly visible. In addition, lecture recording would be handy as backup. In the student computer dashboard, students would prefer more flexibility in the different VC views. Currently, students can only enlarge one view (for example the presentation slides) while all the other camera views remain small. The option to enlarge two screens via a split-screen function was brought up by one of the students. That way students could see both the presentation as well as the teacher enlarged.

5.2.   **Interaction with teacher**
One of the most prominent students' comments is the visibility of the teachers, top to toe. Teachers walk around, make gestures, walk towards the cameras / student screens. Students mention that the teachers clearly enjoy teaching in the VC. Their joy of teaching is a major factor for students to stay motivated.

The view which is favorite is the classroom view, where students see the teacher from the back, standing in front of the screens, displaying fellow-students as well. In addition, students can make use of the tracking cameras (each group has its own camera). The tracking camera allows teachers to approach a group of students and 'look them in the eye'. As we did not test setting with and without racking cameras it is hard to draw conclusions about their added value.

Student quotes on teacher interaction:
- "Contact with the teachers was nice; they even responded to students' facial expressions."
- "You see the teacher talking differently, more actively. You see the teacher having more fun teaching and less reading from the presentation."
- "I would say compared to in person with the same number of people, I think it is just as engaging."
- "It feels like we are in the room with the teachers."
- "The way you can see the teacher is more realistic."
- "The teacher can see all your faces, which I think makes a huge difference. Hence you feel more included."

Teachers confirm students' responses about a more natural environment for the teacher. A strength is: "that you can stand and move, that you can address a student in a targeted manner, although I can't see to what extent that works. But I assume it works fine. Those are two clear advantages."

Interacting with students is not just a matter of technique but technology can facilitate this. A teacher: "In such a setting of a virtual classroom, it gives you the opportunity to very emphatically optimize the presence."

For making eye contact between teachers and students, each group of students, displayed on a single screen can select a view through the tracking camera, that follows the teacher as he/she moves though the room. However, hardly any of the students mention the presence of these cameras. This could be because they did not notice or because they do not regard tracking as useful.
- "I don't know about eye contact, but I do feel like we are being addressed."

The virtual hand-raising option is used regularly but is not mentioned as especially advantageous. Following a quiz or poll, the teacher sees each student's answer displayed on their face. This enables the teacher to respond to each students' answer individually or connect various answers that agreed or did not agree to enhance student interaction. This contributes to the teacher-student interaction. One teacher stresses the importance of this function: "For me, it is very important that you see all these answers at once, and it is very different than seeing all answers in a chat."

From observations in the VC, it was noticed that the teachers presenting were inclined to focus on the screen displaying the slides, positioned bottom left in the studio. As a result, the students whose tracking cameras were positioned on the right side felt less addressed.

During lectures, some of the students turn off their cameras. Students indicate that the timeslot around dinner is one major reason – they do not want to be caught on camera while eating. Teachers indicate that this is troublesome: "Students need to turn their camera on, period! I don't care if they eat goulash or are reading a book. They need to put their cameras on! This is also the case in groupwork." And: "How can you collaborate without seeing one another?"

5.3. Interaction among students

During the plenary sessions, interaction with other students is rather poor. Except for the few students who had spoken a while ago, and the classroom view, the other students are hardly visible. When a student presents, (s)he becomes visible, but this view cannot be enlarged. Students indicate they like to see other students' responses to quizzes and polls. However, they like these responses to be accessible longer, preferably after the session.

Students on student interaction:
- "When someone is presenting, you don't see the others."
- "I prefer to watching the slides but just once in a while I use the camera where you can see everyone."

Interaction with other students in breakout sessions is useful and motivating. These sessions should not be too brief, students mention a period of 20'. And these sessions should not be scheduled too often. One per lecture seems to be sufficient. And MS Teams offers better break-out options than the VC. Students indicate they are familiar with MS teams and its options for channels and break-out rooms, that can easily be prepared by the teacher.
The VC is less flexible than MS teams. Students could not be transferred to another group after the start of a breakout session (and they could not move themselves, as is the case with channels in MS Teams). During iteration 1 teachers could not join break-out sessions. But as the students were still shown during the breakout sessions, we could see that these sessions, in general, were very lively.

- "Breakouts draw away my attention."
- For breakout sessions: "MS Teams is better, because students can enter into different rooms."

5.4. Interaction with content

In the VC, students can focus on the PPT presentation, they can ask questions, make remarks and see those of others. Moreover, students can respond to quizzes and polls. Especially the quizzes and polls are very useful since they are visible to everyone and thus enable reflection. Some refer to it as a conversation starter. Others mention the aspect of deep learning as a result of the quizzes and polls.

The use of online quizzes and polls has, in comparison with face-to-face teaching, a major benefit as it allows students to give answers without being the center of attention. As all students' answers appear on their faces on their screen, they are part of something larger. And the teacher can respond to each students' answer individually or connect different answers that agreed or did not agree to enhance student interaction.

Students' quotes on interaction with content:
- "The quizzes and polls also make you feel a bit more involved in the course and it is really interesting afterwards to be able to see the answers."
- "You have to think about it a bit more and then realize what you know about the subject know and you kind of realize yourself how much you know."
- "The yes/no polls are great for quick questions."
- "Personally, I prefer open questions as they make you really think."
- "Everybody feels it is a bit easier to answer the question. At least you don't feel that everybody is looking at you. You don't feel like you are in the spotlight."
- "The polls also make it more engaging as anyone can answer and have a say. Instead of in a lecture where the professor is not able to address every single person who have their hands raised."

The presentation needs to be well visible during the session, by teacher and students. However, sometimes students view the presentation blurred, or it takes time before a slide is clearly visible. In addition, the presentation needs to be always accessible during sessions. However, when the teacher switches between his presentation and the chat on the so-called HDMI-content screen in the studio, the presentation temporarily disappears for students as well.
Students mention the fact that they prefer to have two focus screens, one for viewing the content and one for adding one of the camera views.

Student quotes:
- "I'd prefer to have two screens/views, the presentation on one side [] and the option to open a second screen where you can see the teacher as well." / "At least having the slides and the professor side by side would be useful. [] That is kind of annoying: not having both screens at the same time."
- "Teachers should see the chat without interrupting the screen with the slides."
- "It'd be better to see the answers of the other people, but they show it for just one second, so it is hard to see. To have it longer on my screen."

5.5. Technicalities
The main aspect mentioned by many students is the audio quality. Especially during the second course iteration audio was poor:
- Part of the students could not hear other students in the plenary sessions.
- Teachers were hard to understand.
- Teacher sound level and student audio volume were off balance. One student mentions: "There seems to be interferences between the two teacher microphones."
- And: "if you could change the sound per user, that would also be really awesome."

On the other hand, one student says: "You go to weConnect and you have this lecture now going on. And you then click on it, and you are connected. It is clear to use. It is the best alternative for offline." And: "No need to download a program, it's just in your browser."

Several students mention the absence of recording options. As a result of online lessons during the Covid pandemic, they have gotten used to the availability of recorded sessions.

5.6. Major strengths & weaknesses
Many students refer to the interactivity of the VC and the visibility of the teacher. Seeing the teacher in a more natural state is also a benefit and motivates students to stay and be attentive. In addition, the various camera angles and the quizzes and polls are mentioned as strengths.
Major weaknesses were the limited visibility of other students, poor audio quality in the second course iteration and the fact that students can only enlarge one screen/view at the time. Students also mention the absence of available recorded sessions. By contrast, teachers were not missing the recording function. Although recording lectures can be beneficial to those students who would like to re-watch the presentation and listen to what the teacher said, it often results in students not coming to the lectures since they can watch it at any given time and day.

The teachers indicated that one of the major strengths for students - an interactive online platform making students' travel superfluous – poses problems for teachers, who still need to travel to a VC-facility: "The disadvantage of the virtual classroom is also the advantage that it is located in one place. Or that collaborating universities, in this case Wageningen University & Research and Eindhoven University of Technology, should also invest in such a classroom. So, every teacher now had to go to Utrecht. If we ever want to do this with universities abroad, I think such a virtual classroom will be an obstacle." Another teacher adds: "You really shouldn't be developing a virtual classroom as a standalone university." Physical presence of teachers in the VC is pivotal. When teachers present in the VC from home or their universities, students experience less teacher presence. In the ideal situation, every university has its own VC facility.

6. **Conclusions**

General
- A set-up like the VC has added value for inter-university or international courses, for plenary lectures, with frequent interaction/discussion. In most other situations either in-person teaching, or other platforms are preferred.
- For full use of the VC at UU, teachers need to travel to one location. We recommend that the choice of facilities and platforms considers availability at other universities.
- The VC has little added value for tutorials, group meetings (where platforms such as MS Teams are preferred). We recommend utilizing the VC mostly for interactive synchronous lectures for inter-university or international courses.

Studio set-up
- The set-up is important for motivation of both teachers and students, as confirmed by literature. Students indicate they prefer to view the teacher like in a face-to-face class setup.
- We recommend designing facilities where teachers can walk around and can be seen top-to-toe.
- Moreover, we recommend that the screens in the studio are positioned in such a way that the teacher can see all students easily and respond to their questions, gestures and answers to quizzes and polls. This means, amongst others, that the screen displaying the teacher's slides should preferably be positioned in the center of all screens. In that way, the teacher's viewing direction will be focused on the center and the students experience more eye contact.

Viewing the teacher
- The camera positions in the studio determine how the students can view the teacher(s). Students like to be able to select camera views. This contributes to maintaining student motivation during the session.
- We recommend combining a front with a back (classroom) camera. The use of tracking cameras allows teachers to walk towards student groups. And if students lose track of the teacher, they can use the fixed front camera. The added value of tracking cameras needs further testing.

Student visibility
- In the VC, the visibility of other students by students was regarded as poor. Therefore, we recommend that students can see each other via a separate student view display.
- Breakout rooms are useful for group discussion or assignments. We recommend using breakout rooms but to a limited extent. If used, breakout sessions should not be too short.

Content
- Students need to have access to the content constantly during the session. We recommend that students can select and enlarge two displays at the same time (e.g., teacher view combined with presentation view).
- We recommend that students can, always during and following a session, download presentations (or other materials). During the lecture, the content screen needs to respond swiftly (avoid slides that appear blurred).

Interaction
- The use of quizzes & polls tools is essential. As confirmed by literature, these stimulate deep learning and functions as interaction starters. We recommend the integration of tools for quizzes and polls.
- Viewing quiz/poll answers in combination with students (on students' faces) stimulates interaction between teacher-students. The way the VC displays students' answers is much more direct and interactive than displaying the answers in a chat. In addition, viewing each other's quiz/poll answers stimulates student-student interaction. We recommend the use of quizzes for several reasons; for enabling teachers to check student's understanding or start interaction and for students to see how their peers respond.
- We recommend that the results of quizzes and polls are accessible for students during and following a session (anonymized). For swift response by teachers the studio needs to be equipped with a screen showing the chat/questions.

Audio

- The audio quality is pivotal, between teacher and students, and between students. We recommend that teachers can regulate audio in the studio and on the online platform.

Recording sessions
- Students like to have the option of viewing recorded sessions. However, for the purpose of having lively sessions with sufficient students present, teachers are reluctant to record sessions. We recommend that teachers have the option to record the lectures for later viewing by students.

Preparation and support
- The VC - studio set-up and the online platform - differed substantially from what teachers were used to. As a result, they needed to have extra introductory sessions, needed extra time to prepare their lectures, and the presence of a technical moderator during the sessions was required.
- We recommend that the design of a studio and online platform takes into account the proper teacher support.

Literature

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Annex I – interview questions for students participating in the IUSC course.

Over the course of 10 weeks, the students were interviewed online four times, after 2, 4, 6 and 8 weeks. The students were interviewed about a number of topics, including the student collaboration, coaching and interdisciplinary work. Below, only the questions about the virtual classroom are listed.

Interview questions week 2
15.   How accessible are the lecturers in the virtual classroom?
      a.   In what ways (eye contact with teacher, teacher's gestures, oral contact, digital hands, ..)
      b.   What about the quizzes and polls: do they help you in understanding the content?
      c.   What about the polls as interaction starters? Some lecturers use the polls a lot, others very limited. What do you prefer?
      d.   How engaging is the interaction with the teacher in the VC?
      e.   How was your experience in the break-out session (preparing pitch 15 Feb)

16.   Which strengths & weaknesses of the VC do you perceive so far? Regarding weaknesses: Tips for improvement?
      a.   In comparison with MS Teams
      b.   In comparison with in-person teaching
      c.   Do you feel safe in the VC?
      d.   Do you like the fact that the cameras (including yours) have to be turned on.
      e.   What about the VC-screen in your browser/ what aspects are pleasant? What is redundant or should be improved?

Interview questions week 4
15.   How accessible are the lecturers in the virtual classroom?
      a.   In what ways (eye contact with teacher, teacher's gestures, oral contact, digital hands, ..)
      b.   What about the quizzes and polls: do they help you in understanding the content?
      c.   What about the polls as interaction starters? Some lecturers use the polls a lot, others very limited. What do you prefer?
      d.   How engaging is the interaction with the teacher in the VC?
      e.   How was your experience in the break-out session (preparing pitch 15 Feb)

16.   Which strengths & weaknesses of the VC do you perceive so far? Regarding weaknesses: Tips for improvement?
      a.   In comparison with MS Teams
      b.   In comparison with in-person teaching
      c.   Do you feel safe in the VC?
      d.   Do you like the fact that the cameras (including yours) have to be turned on.
      e.   What about the VC-screen in your browser/ what aspects are pleasant? What is redundant or should be improved?

Interview questions week 6
14. If you followed a similar course next year, would you prefer VC, Teams, in person, or a combination?
      a.   In case of inter-university / national / international courses
15. Quite some students were missing during the last VC sessions (SDGs and the role of cities & Worldview Journey). Do you have an idea why
16. We saw that the majority of students do not turn on their camera during lectures. Why is this?
17. How can we get students to become more active?

Interview questions week 8
7. What about the lecture in the VC by Jonas Torrens, 21 March?
8. What about the lecture and presentations in the VC (with Arjen and Michiel)?
9. What did you enjoy most about the sessions in the VC?
      a.   Top 3 strengths + why/examples
10. What did you enjoy least about the sessions in the VC?
   b.   Top 3 weaknesses + why/examples

Annex II - Virtual classroom, students' manual

For participating in the virtual classroom, you can use your browser. For proper use of the interactives offered, it is **crucial that you use Google Chrome**. If it is not installed on your laptop of MacBook, ensure you will do so in advance of the first session (www.google.com/intl/nl/chrome).

Create an account
You need to **create an account in advance**, by following these steps:
In your Chrome browser, go to https://uu.edu.barco.com
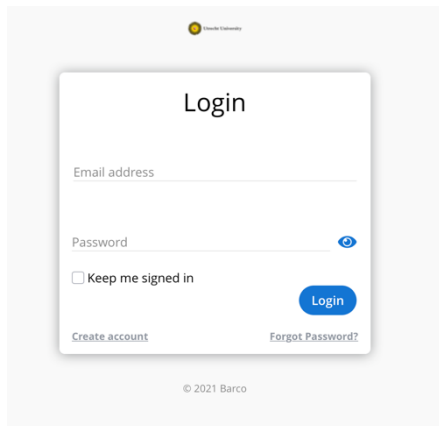
Create an account (via 'create account'). You better do this well in advance (for example a day earlier)

If you have questions about creating an account, email Frans van Dam (f.w.vandam@uu.nl). During the session you can be in touch with the moderator of the day: [name, email address].

Before logging in
To get maximum benefit from the Virtual Classroom sessions, there are a few do's and don'ts.
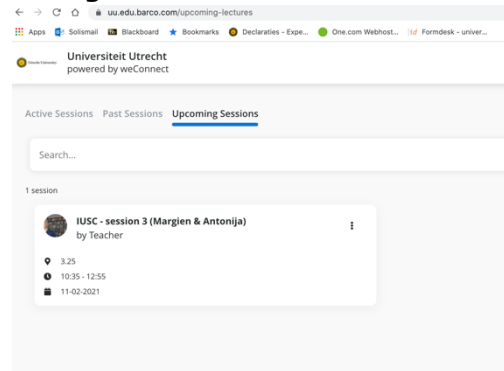

- ✓ **If possible, try to sit alone in a quite area.**
- ✓ **Use your own device (laptop).**

- ✓ **Use a headset.**
- ✓ **Be on time.**

- Sit in an area with a lot of background noise.
- Share a device/screen with other students.
- Use your laptop microphone.
- Last minute log-in.

During the session

Login with your account prior to the start of the lecture. You will then see the lecture under "Active Sessions" (or if you're too early under "Upcoming Sessions"). Click on your session: **Test session Online Studyvisit P4D Bangladesh on Citizen's Charter.**

- Select role 'Participant' and click 'Finish'.
- Follow the instructions to test your camera, speakers, microphone and network connection. At any moment before a session, you can already TEST whether you are well equipped to join the session by going for the 'Test your setup' option top right when
- Welcome to the session!
- Maximize your browser window for the best Virtual Classroom experience (F11 on laptops).

For having proper interaction in the virtual classroom, it is **crucial that you keep your camera turned on**. When entering the classroom, ensure that your microphone is switched off. The lecturers will explain more about the use of the virtual classroom.