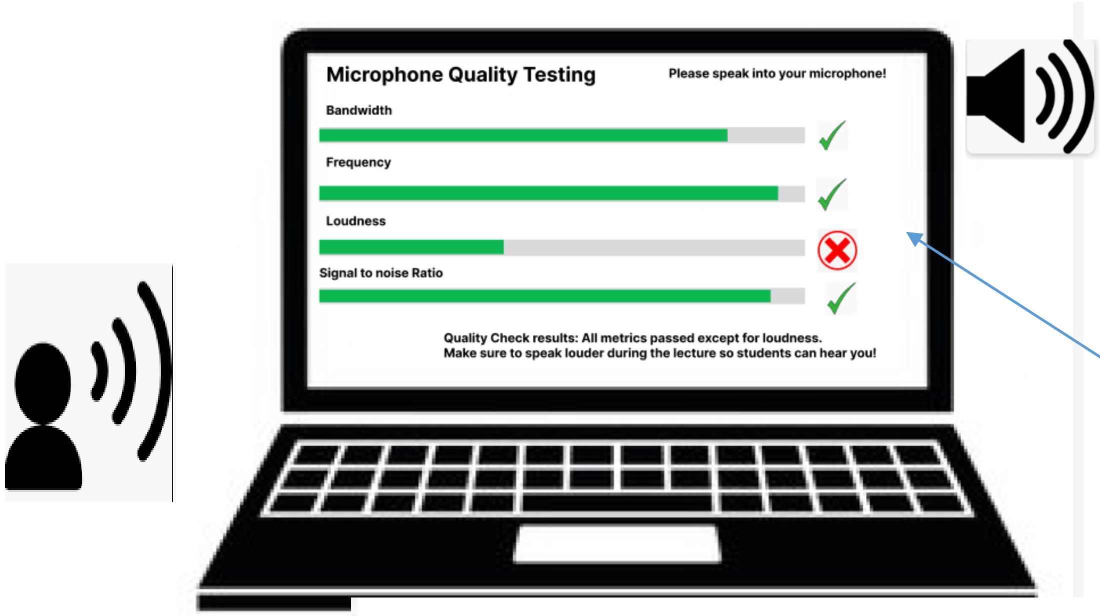
Conceptual Design and Analysis of LectureHub

Part 1: Conceptual Design

During my previous ethnographic study of the use of educational technology, we noticed several problems affecting the quality of the user experience. The lack of feedback and quality assurance of the microphone during zoom meetings made it difficult for students to engage with the lecturer, with some even leaving the lecture all together. Also, with regards to the usage of mentimeter, we noticed that users are uncomfortable with interacting with the poll as well as the discussions that took place because of the poll. Due to mentimeter being a separate application, some students wouldn't be able to use the application due to e.g. their phone being out of charge, or simply not wanting to go through the hassle of switching to another device. I have designed an alternative version of traditional educational technology called LECTUREHUB that aims to combine the uses of both applications as well as including extra functionalities and multi modal approaches to solve the problems mention, and to facilitate higher quality interactions between all types of users.

The first feature that we have included in this system is a testing feature for the microphone. At the beginning of every meeting the lecturer will speak into a testing system, and the sound will be tested against a variety of metrics including bandwidth, frequency, loudness, sharpness etc. [1] This will be tested from the user's perspective so we can gauge whether the user will be able to hear the sound properly or not. If it passes the test, the lecturer should see a green tick and a statement saying that their mic is of good quality and they can proceed with the lecturer. They also will receive a sound as a notification which people normally associate with being a correct or passing a particular test. This is done that the system can abide by Norman's mapping as the controls, in this case being the green tick and the sound notification, represent the desired outcome of the user which is to pass the quality check and deliver a good lecture. We also included this feature so that the system abides by the Norman's Principle of giving feedback, as with this feature the lecturer is able to gauge whether he has successfully connected the microphone or not.

Figure one shows a brief storyboard of improving the mic quality by providing haptic feedback during the lecture by utilising calm technology.



In figure one: The user utilities their microphone and the system Is able to perform quality checks and converts the audio of the user into a particular score which is then outputted into the interface as seen. The outputs are either in the form of green ticks or red crosses indicating whether it passes or fails the quality check. The users own voice is then outputted so they know how they will sound during the lecture.

Figure 1: As the lecturer begins the lecture they will begin to receive haptic feedback in the form of subtle sound and text notifications that allows them acknowledge that there is an issue whilst allowing them to not lose their focus of the lecture at hand. This prevents breakdown

Figure 1

Because of this functionality, user interactions can now be enhanced as there is no barrier between them and the lecturer due to the quality improvements of the microphone, and they can therefore hear the lecturer and respond appropriate without trouble. This allows them to be in a state of being “Ready to Hand” as they are engaged with the lecture and prevents them from being in a state of “Present-at Hand” where they are experiencing breakdown and are encountering obstacles which prevent them from having an optimal user experience. If there is a reduction in the quality as per the metrics, the system will be able to detect this and give subtle sounds and pop ups that are non-intrusive to prevent distracting them from the lecture so they can make relevant changes. This is an example of utilising calm technology where we have created this system in a seamless way to allow Lecturers to focus on their classes without distraction.

Another issue that was observed with zoom was the inability to cater to students of different languages and mobility types. Users that may not speak the same language as the lecturer (or not as well) are at a disadvantage. They are also at a disadvantage when it comes to the chatbox as they won't be able to communicate their questions/thoughts effectively. These problems will be solved through the usage of wearable technology. Students can wear smart earbuds that translate the speech lecturer in real time to the language that the user has chosen. Users can also speak into the earbuds to communicate in the chatbox or meeting which then gets translated to the common language of the students and lecturers. If the user wants to use the chatbox their speech will get converted into text for the other students to see. This introduces multiples modes of usage for the chatbox and allows e.g. visually impaired students to simply use their voice as a means of communicating using the chatbox. Communication will be tracked and students shown to be more collaborative in the lectures will be rewarded with extra points and recognition from the lecturer. This introduces an element of *gamification* and users are incentivized to collaborate more during the lectures and reflect on how well they are engaging in the lectures. This system therefore supports collaboration as per the principles of CST [1].

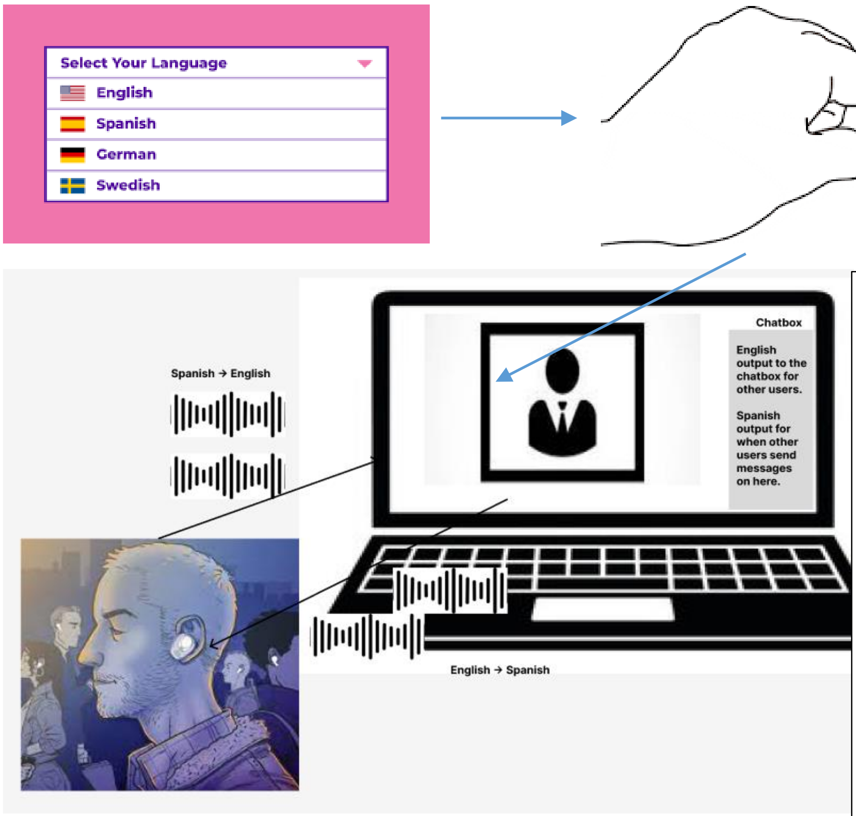


Figure 2: shows a storyboard of the user selecting their language for the audio and chatbox during the meeting. We then see the user putting on the smart earbuds and proceeds with the lecture. As can be seen, the audio when the user speaks into the earbuds is translated into English and the smart earbuds translates the audio from the lecturer into the chosen language of the user. This is also used for the chatbox, where if the user has multiple modes of using the chatbox either through typing or through speech. So when the user here speaks for the chatbox in Spanish it gets converted into English for the other users and vice versa.

An additional feature included was the embedded quiz feature that facilitates educational quizzes to test students understand during the lecturer. A previous issue was that students would have to switch to another device in order to load up another application to take part in a quiz, many of them found this a hassle which caused some students to disengage once this part of the lecture began. With this feature, students can now navigate the quiz without having to switch to a different setting which keeps them engaged and "ready at hand" as the poll is on the application itself as supposed to it being a separate entity.

In order to increase ease of use, we have included a multi-modal input approach when it came to answering questions for the quiz. Previously users were restricted to tapping the answer that they thing is correct or typing their answers where necessary. In this system however, users are able use their voice as an input to their answers. This allows more students for e.g. those with mobility issues to participate in the quiz. For e.g. in an MCQ if they believe the correct answer is E they can simply say E as their answer and the system can process this accordingly. We have also included gesture based input as one of the ways to input an answer. With this mode of input users can simply point to the answer the system will interpret the gesture accordingly. This is also effective when questions involving matching a pair come up where users can simply point around the pairs that they think match and the system can interpret this as input. Increasing modes of input enhances user experience as it opens the door to more types of users that can interact with the system such as those with limited mobility.

Figure 3: Here the user is facilitating multiple modes of input to facilitate in the quiz that's embedded in the app without having to switch devices. Here the user makes pointing gestures and system is able to track where she has pointed and track that as their answer to the question. They are also able to post audio explanations to their answers which are attached to the answer for others to hear. If they are wearing the smart earbuds their explanations can be translated as seen in figure 2.

We noticed that more introverted students wouldn't take part in discussions and would only input their answers on the app, this would prevent them from expressing their point of view regarding a particular topic and could perhaps hinder their learning experience. To prevent this, students are also able to attach audio explanations to their answers which will be converted into an anonymous audio that everyone gets to hear and benefit from. This increases the element of privacy for the student and allows him to interact individually with the system. This can also now promote more discussions on the social context as others give their responses to what the student has posted.

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Part 2: Analysis

Conducting a DCA involves describing how information is dispersed across people and their environment, their technologies and their social context. [2] It also describes what goes on internally (the user's mind), the external and the flow and transformation of information throughout the usage of a system. Considering these factors allow us to tailor our design in a way that allows computation to be simplified and give an overall better user experience.

Conducting an Activity theory based Analysis theory involves depicting factors such as the subjects, which are normally people partaking in a particular action, goals, operations, tools to achieve those goals and overall transformations that take place to achieve a particular outcome. We also analyse the environment, the social and culture context in which activities take place to achieve a goal. Below is diagram of what an activity theory based analysis would result in.

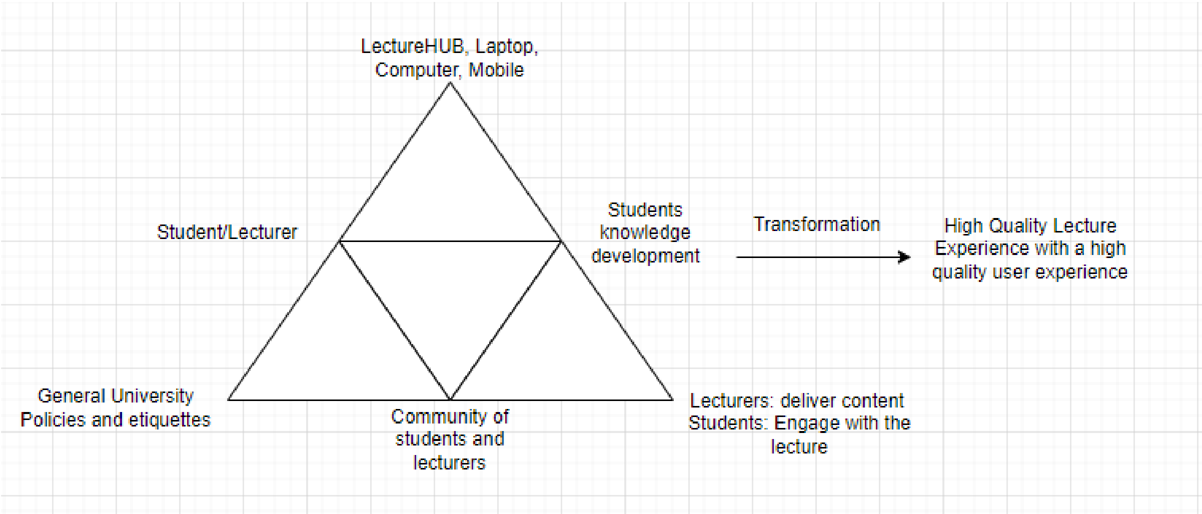

Figure 4: Shows results of activity theory analysis where we include factors such as the subject, rules, tools, community, division of labour, object and outcome.

Distributed Cognitive Analysis

The first element of conducting a DCA is the unit of analysis. This is a "collection of individuals and artefacts and their relations to reach other in a particular work" [3], Every "unit" mentioned here is used to achieve a computational goal. In LectureHUB, the units of analysis include:

- User
- Laptop
- Screen/Monitor
- Microphone
- Audio Interface: to facilitate users speaking into the system and processing their audio from the mic.
- Speaker
- Mobile phone
- Server storing the answers from the quiz
- Audio analyser: to test microphone quality
- Speech recognition software
- Machine translation software
- Gesture controller (for gesture based input)
- Smart earbuds for audio input/translation.
- Lecturer
- University
- Chosen Language from the user's side.
- Chatbox Feature
- Embedded quiz Feature.
- Lecture Content

Another element of a DCA includes the memory representation. These are both internal and external. These are pieces of information/data which must be known and remembered in order for the system to function at its finest and achieve the desired tasks. The goal of our system is to reduce the cognitive load on the user's end (internal) to make the system easier to use.

The internal representations (mental) in LectureHub:

- The user's Language choice. They must know which language works best for them to prevent communication issues. They must remember what languages are available to them.
- The user's decision for the quiz answers.

- Recognition of information being outputted from the lecture: this allows them to utilise the systems features to communicate effectively with the lecturer. Vice versa for the lecturer interacting with the students.
- Recognition of what is being communicated in the chatbox: this allows them to utilise the systems features to communicate effectively with others.
- Recognition of any information/instructions regarding the quality of their microphone and haptic feedback.
- The lecturer keeping tracking of students.

Below are the internal representations (computer) in LectureHub:

- Any relevant University and student data
- Wireless internet Connection
- Speech recognition from both the lecturers and the students.
- Processing of gesture data from the students when participating in the quiz.
- Textual input from the users when utilizing the chatbox.
- The language that the user has chosen so that the system can carry out necessary translations.
- The sound metrics coming from the audio of the lecturer for quality assurance purposes.
- Communication data from the students: for gamification purposes.

Below are the external representations:

- Users answers and any results from the quiz displayed on the screen
- Visual haptic feedback during quality testing of the lecturer's microphone.
- Output of text in language of users choosing for the chatbox.
- Languages available to the user displayed on UI for them to choose.

The next element of a DCA is the information flow. This involves a description the channels in which information flows across all aspects of the system. This also includes the direction of flow between internal and external memory representations. These include:

1. Information regarding the quality of the microphone in the form of haptic feedback. This will be audio and visual and will be communicated from the system to the user when testing their microphone or if there are any issues with it during the lecture.
2. The actual lecture content: from the lecturer to the user via LectureHub through the requested language of the user.
3. Choosing of language from the user: they will either use audio to select the desired language or will tap/click onto the screen with their preferred language. This will flow from the user to the system.
4. Smart earbud language translation: from the user to the system and vice versa. As they speak it will be translated for the other users/lecturer and also translated into text when using the chatbox and vice versa. This is unidirectional.
5. Gesture commands from the user when selecting an answer for the quiz. The system then recognizes the gestures to select a particular answer.
6. Discussions between students as they discuss their opinions on the answers for the quiz.
7. System outputting results from the quiz in visual format so the user can reflect on how well they performed.
8. System outputting communication statistics to the lecture so the lecturer can reflect on who is engaging the most and how to engage more users with the lecture.

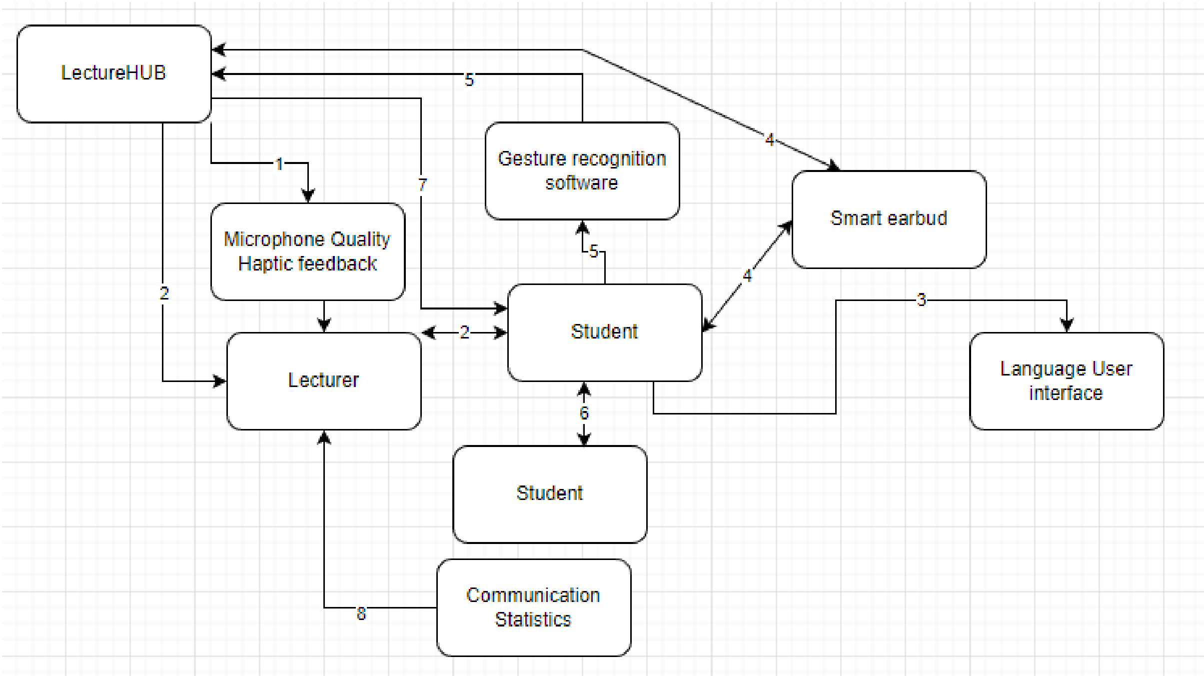

Figure 5 shows Information flow that takes place within the system with different objects and actors. The number refers to where in the number system list above that the information flow is referring to.

The final stage of a DCA is the processing stage where we identify what needs to be processed to successfully use the system.

Internal Computation:

- The lecturer needs to process haptic feedback from the system regarding their microphone in order to conduct a lecture with a microphone of high quality.
- The user needs to identify the language that they would like to hear/see the lecture in. This way it can get translated accordingly and there are no communication barriers.
- The user must identify the amount of gesturing required in order for the system to recognise it and correspond it to an answer on the quiz accordingly. Doing too much can confuse the system and doing too little can lead to the system not picking up any input.
- Students must identify their desired quiz answers using the right gestures.
- Students and lecturers must interpret communication from fellow students to follow up with the appropriate actions.

External Computation:

- The system must interpret and process audio input from the lecturers and the students.
- System must interpret and process gesture input from users when answering the quiz.
- System must interpret what language the user has chosen and then process and conduct the relevant language translation from the user to the system and vice versa.
- The system must interpret the answers that the user has chosen for the quiz
- The system must be able to process all the communication that has taken place throughout the lecture to reward most engaging students.

Overall, conducting a DCA has been very helpful in this context. As this is a complex system with many components and interactions taking place we can gauge the processing and computation occurring internally and externally. We also get an idea of what goes on with the user internally which is something that activity theory doesn't place much emphasis on. We can then identify any potential issues where we can think more creatively about our system to solve them. However, conducting a DCA has a very limited scope where we are only concerned with the system and the perspective of the users. Other external factors such as social, environmental, that can affect the system are not considered. This is where conducting an activity theory would have helped as it considers "community" as one of its aspects. It is also subjective because factors such as the memory representations, unit of analysis are open to interpretation and could be seen as right by some but wrong by others.

Word Count: 1154

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