Post-pandemic education for the students of the future

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Introduction

- The COVID-19 pandemic has had a major impact on the field of education
- A series of changes appear to be permanent or to represent the basis of a “revolution” in education
- Experts believe that future education should be a combination of:
  - classical intelligence, resilience, and emotional intelligence
  - classic face-to-face learning and online learning
- It is estimated that, in 2020, approximately **70%** of the world’s students were affected by the pandemic ⟶ **the online learning market has grown exponentially**
- Goals:
  - discuss the **distributed classroom** paradigm
  - motivate its necessity
  - propose an implementation

Massive Open Online Courses (MOOCs)

- Offered by online platforms such as Coursera, edX, or Udacity
- Allow the use of the Internet for the sharing of free online courses
- An area that existed and was popular pre-pandemic
- In and of themselves, they are not able to fully disrupt the traditional learning methods
- They are costly to develop and only available to rich institutions
- There is a vast number of students starting but never finishing a course

Research-Based Learning (RBL)

- Attempts to combine classroom teaching with research methodologies
- Students are encouraged to find their own way towards a conclusion, in order to help them develop qualities such as **critical thinking**, **analysis**, **argumentation**, and the ability to sift through sources and **extract or deduce** the information that they require
- The aim is to allow students the freedom of choice, while at the same time helping them with important skills such as **finding**, **processing**, **organizing**, and **evaluating** information
- Helps students learn how to collaborate and communicate
- Has become more popular during the pandemic since it reduces the need of a step-by-step guidance of the student by the teacher

Digital Labs

- Interactive tools which allow students to recreate experiments in various areas
- This includes collecting the data, processing and analysing them, and drawing conclusions about the results, all done through advanced simulations
- Part of the RBL process
- Allows students to be provided with the data and scientific conditions to run their own experiments

Virtual Labs

- The evolution of the Digital Labs
- Offer advanced **virtualization** of laboratories that can be accessed **remotely**
- Offer access to students that do not have such labs at their universities, or cannot physically be present in the lab due to various reasons (such as the COVID-19 pandemic)
- Can be combined with other online learning tools (web resources, animated demonstrations, etc.) for a more immersive experience

The Distributed Classroom

- Combines eLearning with MOOCs and extends them with Digital and Virtual Labs
- Entails a distribution of the entire education experience in:
  - **space** → the students and the teacher can be located in different places
  - **time** → teaching can be both synchronous and asynchronous
- The time and space distribution can happen simultaneously

The Distributed Classroom (2)

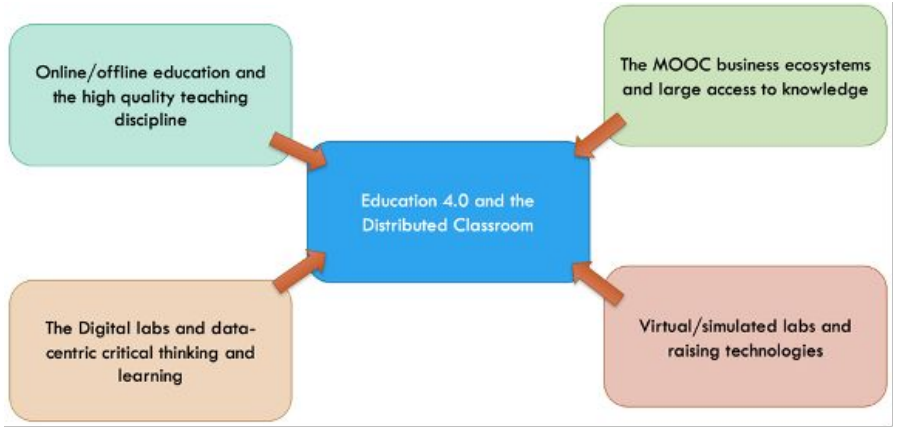
- Example:
  - a teacher might be physically co-located in a classroom with a group of students and present them the lesson
  - at the same time, the presentation is transmitted to a different group of students located in a separate classroom in a different location
  - it is also live streamed to other students that may each be in their home
  - the presentation is recorded for asynchronous viewing
  - each separate group of students can have a teacher or an assistant with them that could aid them and facilitate online teaching
  - interactions with the teacher can take place **directly** or **indirectly**
  - wherever students are located, they will have access to the course laboratories

The Distributed Classroom (3)

- These synchronous and asynchronous interactions improve the students' experience by adding the **social component** of learning
- This brings additional motivation and involvement and was found to be missing at regular MOOCs
- The main goal of the distributed class can be reformulated as follows:
    - *"Distribute not just learning across time and space, but the actual classroom experience – including synchronous interaction – even while removing the requirement to attend at a certain time and in a certain place"* (Joyner, D.A., 2021. Mechanisms for Supporting Emergency Remote Classes: Towards a Distributed Classroom. Georgia Institute of Technology)

Education 4.0

- A mix between **learning** (where online lectures are complemented with self-paced online practice activities) and **science** (where students are co-designers and co-creators of new knowledge)



Education 4.0 (2)

- Laboratories are the main generators of both **education** and **innovation** capabilities
- By digitally enabling laboratories and connecting education and research institutions, we believe that the tide of innovation and future education capabilities can be turned
- The **challenge**:
  - dealing with the vast amounts of data that come from experiments in a variety of scientific areas
  - there is still a collective inability to benefit from them truly and completely
- We believe that the solution is to **connect** and **corroborate** data from disparate sources
- **Connected data** is key to transformation

Education 4.0 (3)

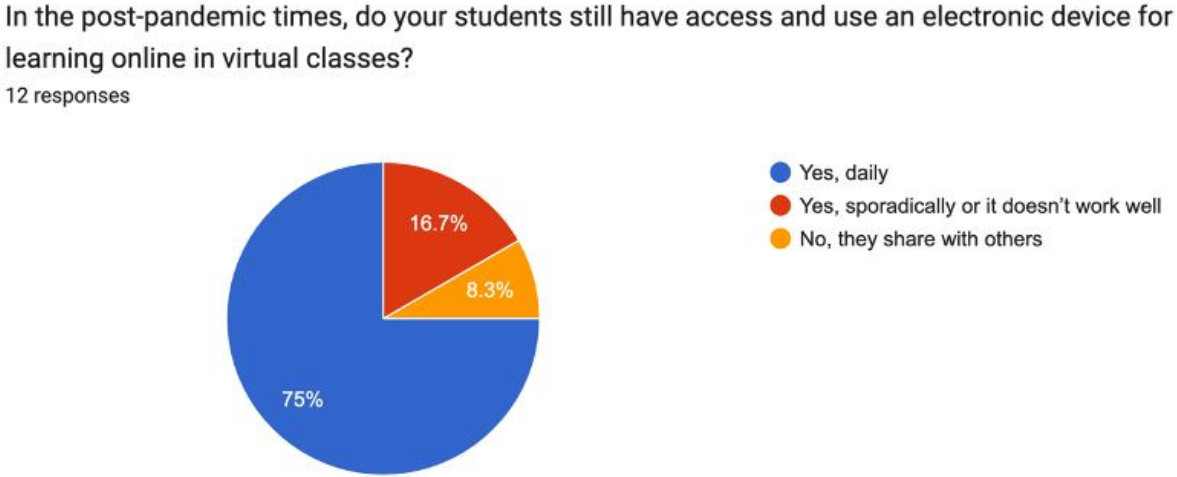
- According to the vision of the European Commission, the EU's digital decade will be focused on **data**, **technology**, and **infrastructure-based digitalization**
- The focus of universities and other education or research institutions should be on transforming the way they utilize the data that they generate, with the aim of obtaining **digitally-transformed labs**, using technologies such as IoT, AI, or ML
- The development of international networks of interconnected smart labs can provide students from Master and PhD levels from different parts of Europe with flexible digital study options
- Such a network of smart labs can thus provide **digital readiness** to universities, but also **resilience** of educational services in the face of unexpected events, like the COVID-19 pandemic

Education 4.0 (4)

- Our vision combines aspects of all four previously discussed directions in an online environment
- At the core, it is about the adaptation of the **learning methods** (Education 4.0) and **supporting infrastructure** (distributed classroom) to make use of active **Research-Based Learning** over online distributed **virtual labs**
- We thus envision universities working together to create a training environment where students learn the use of digital technologies through experimentation at their own pace, by actively working with data and applications over smart remote laboratories

Motivation

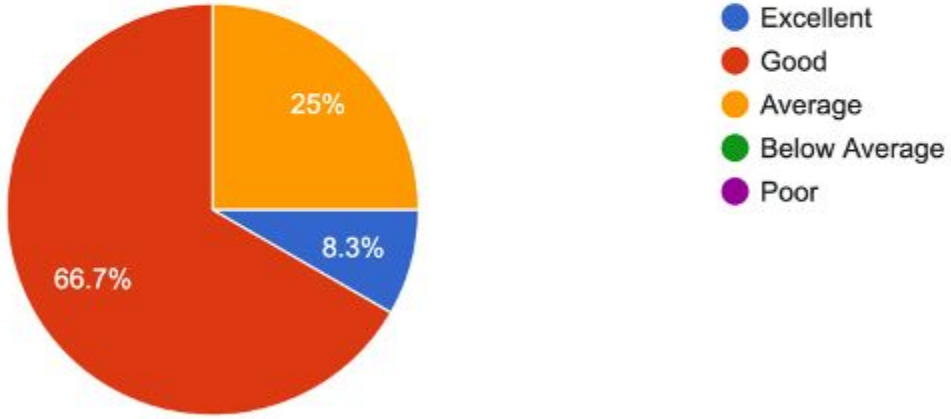
- Collected data from five universities located in different European countries (Romania, Portugal, Italy, Israel, Spain)



Motivation (2)

In your experience, how do your students feel overall about distance education? Consider the benefits when asking them, like the fact that they can learn in their own style and pace the curricula.

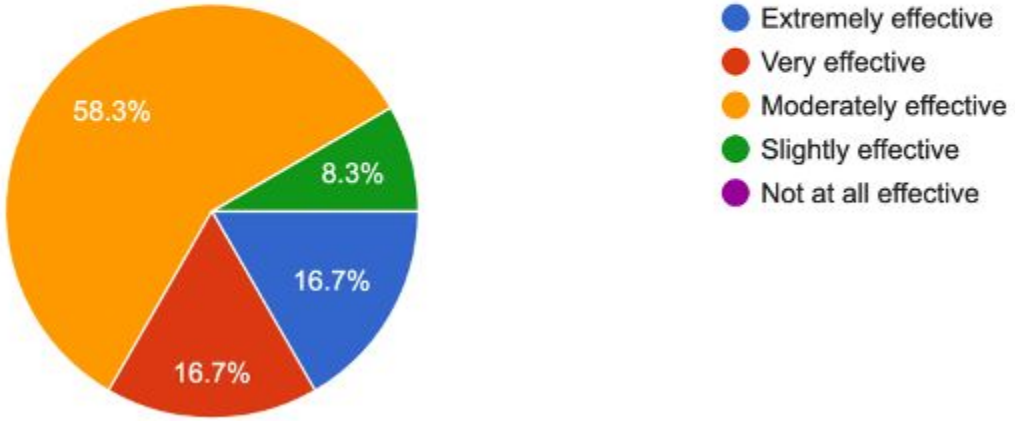
12 responses



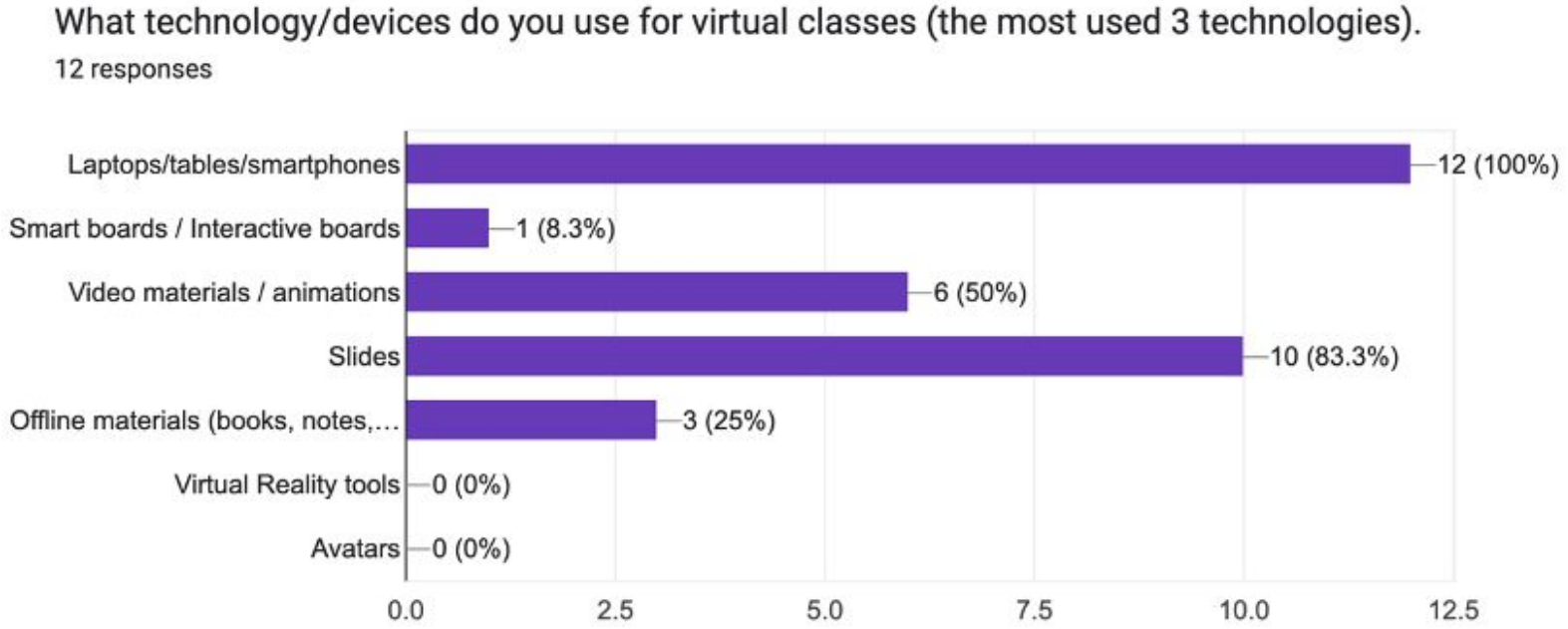
Motivation (3)

In your experience, how effective has remote learning been for your students compared to other means of teaching?

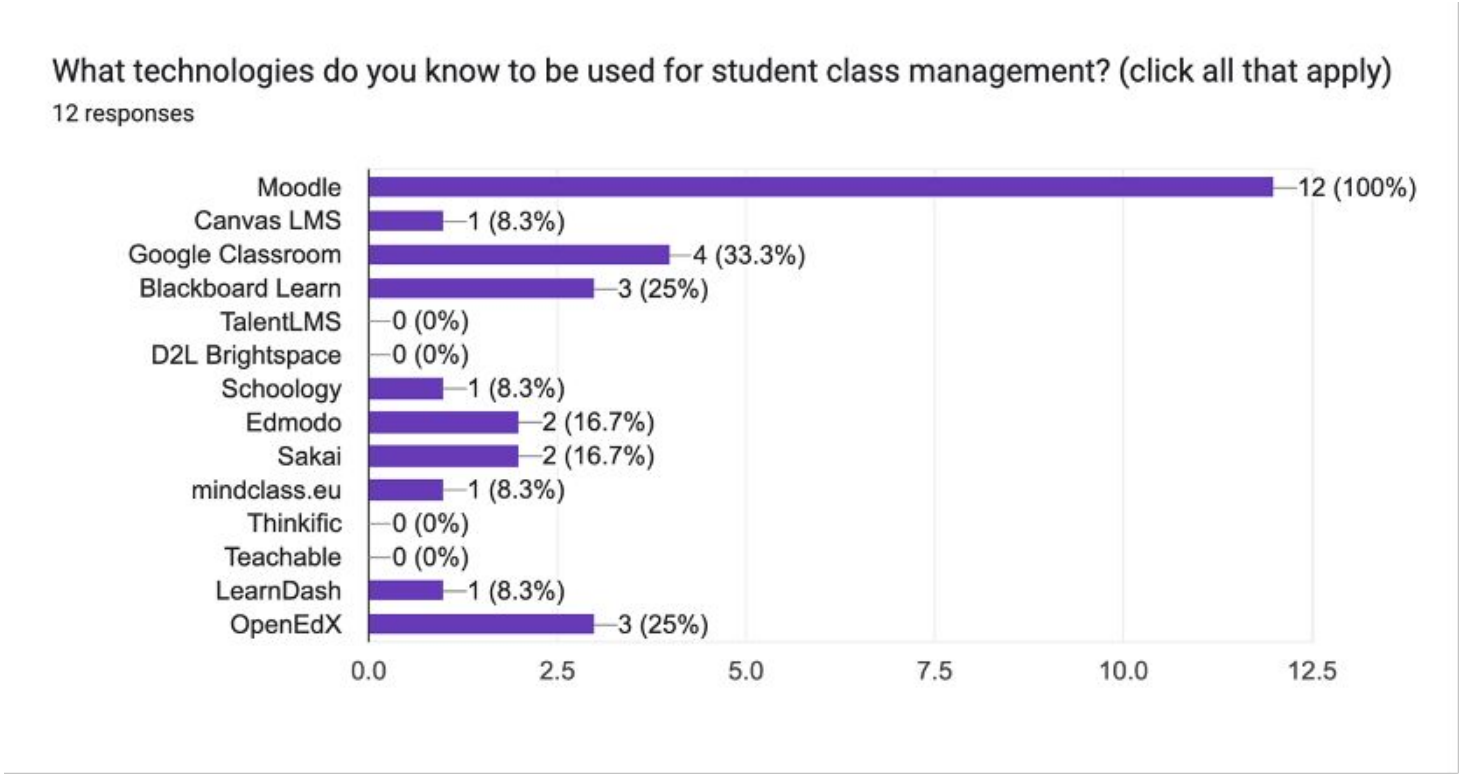
12 responses



Motivation (4)



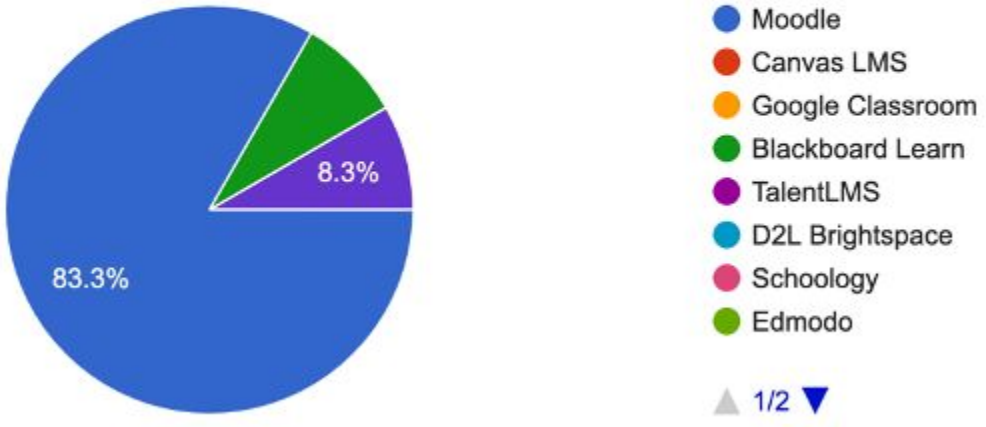
Motivation (5)



Motivation (6)

What technologies do your institution use for student class management? (select all that apply)

12 responses



Motivation (7)

- When asked what the most engaging activities that happen in an online-based class are, responders mentioned:
  - activities that involve students in solving a problem (e.g., laboratories, seminars, project development)
  - the fact that students can see live coding, can share a screen or an editor (of documents or even of code) and that the overall experience seems more hands-on
  - webinars
  - practice exercises, demos, short tests, short evaluation questionnaires

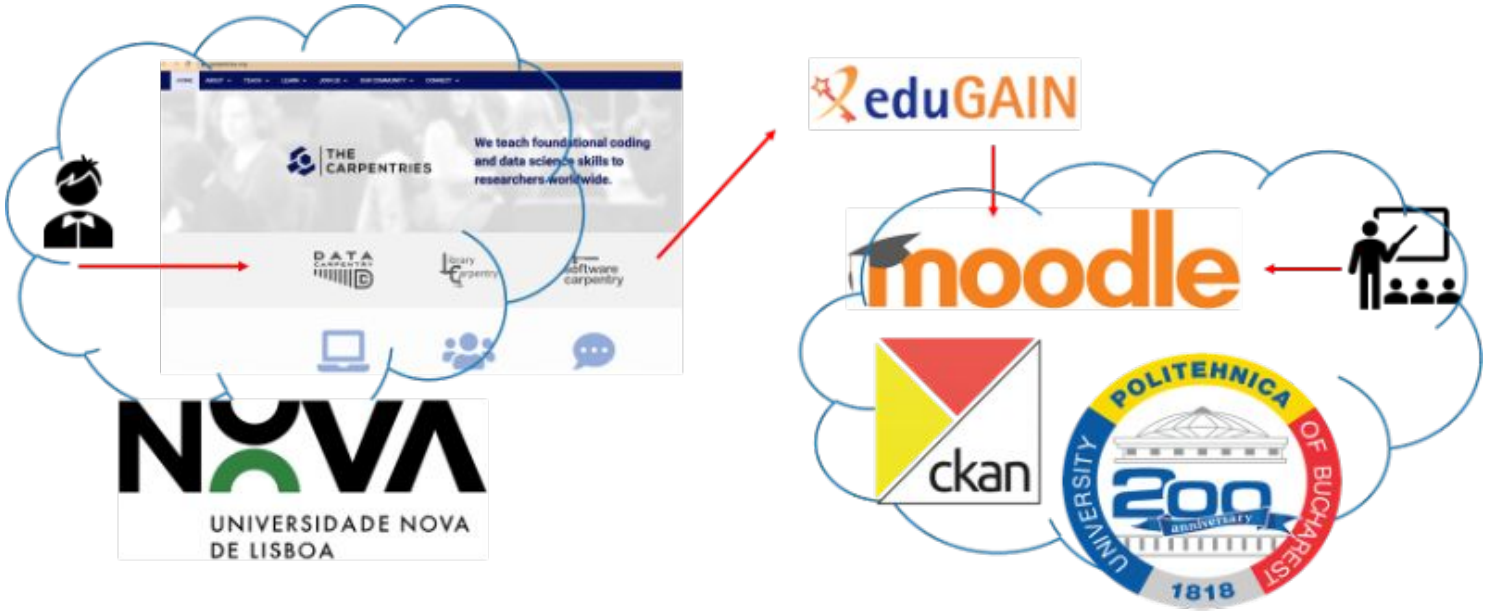
Motivation (8)

- When asked what is one thing they believe would make online teaching more engaging for students in an online-based class, the participants answered:
  - students must be actively involved in order to stimulate them
  - dialog should be encouraged
  - students should be given the possibility to interact remotely with physical objects such as instruments or sensors
  - students should be offered the possibility of using laboratories in real time for making measurements and experiments
  - collaboration and self-evaluation should be encouraged

Implementation

- Moodle is one of the most preferred LMS platforms to support online teaching activities, but its main issue is **locality** (it is integrated with only the Identity Provider service of an institution)
- Students should have access in their classes, as much as possible, to data, so universities should be able to give access to them → we propose an integration with **eduGAIN**:
  - a service that connects identity providers, simplifying access to content, services, and resources
  - it can register identities on LMSes (such as Moodle), or on institutional (CKAN, Dataverse, Invenio) or generic (Zenodo) data repositories
  - allows a student from an institution to be correctly recognized in the data repository at a different institution with her credentials

Implementation (2)



Implementation (3)

- eduGAIN also allows for the registration of other digital tools
- Jupyter Notebooks:
  - a framework for interactively implementing, documenting, and sharing data science projects as notebooks
  - documents composed of code (e.g., Julia, Python, R, etc.) and visual elements (text formatting, figures, URLs, etc.), as well as experiment results (figures, tables, etc.)
  - allows teachers to develop and share interactive lessons
  - many universities provide classes based on Jupyter Notebooks
  - **JupyterHub** → offers a full Jupyter deployment that can be set up in a private datacenter or in a remote cloud
  - **Binder** → creates custom Jupyter Notebook instances automatically from a repository, and allows them to be shared

Conclusions

- All these digital tools could easily be part of the educational system, part of activities in classes belonging to the IoT or BigData domains, and they can be integrated with eduGAIN to allow for remote access to educational resources for students from all over the world
- They can give students access to resources without having to install and maintain anything, they simply connect to their own copy of the environment and develop content as directed
- Such an approach has the potential to be used as a teaching tool for both specific course content and programming languages, allowing for flexibility for instructors and students, or for accessible coding environment

Thank you!

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