

## PD B5: Rapid Prototyping

GNG 5120/4120[A] Technology Entrepreneurship

School of Engineering

University of Ottawa

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## Introductions:

### Current Problem:

Coding has long been a core part of skills training. Although practical applications of programming often involve the use of computers and specialised text editors, we found that most higher education institutions still rely on traditional written examinations to assess students' programming skills. Not only does this exam format limit the complexity of the programming problems that can be tested, it can also bias subjective assessments due to misunderstandings of written descriptions and handwritten code. Furthermore, this approach does not fully simulate the experience of an actual programming environment, such as compilation and debugging of code. While some online exams offer programming questions in a multiple-choice format, they often fail to capture the real-world coding action of students and whether they are a fair test. There is currently no solution on the market that provides students with the ability to write, compile, and view code output in an online environment while ensuring the fairness and integrity of the exam.

### Solution:

The idea is that the student boots the computer into a preconfigured operating system from a usb flash drive handed out right before the exam begins. Student identity verification and exam writing time limitation is handled by the invigilators present in the classroom. The operating system chosen is Ubuntu Linux, version 20.04.2, which is configured to have multiple programming environments to choose from. The student is given access to a regular user account with a home folder, but no root access or otherwise deviating privilege configuration.

This ensures that the student is unable to remove the limitations imposed on the system. The use of prohibited resources is prevented by blocking Internet access, blocking or removing the drivers for external usb-storage devices and removing the man-pages, the software documentation materials usually found on Unix systems such as Ubuntu. Internet access is blocked by configuring rules in ufw, the default firewall configuration tool for Ubuntu, to not allow any incoming or outgoing connections, except for outgoing traffic on port 80 to the Moodle server.

## Our Close Competitor:

### Benefits of bright spaces

- Comprehensive LMS Features: Brightspace offers extensive course management, content delivery, and assessment capabilities. This includes quizzes, assignments, and discussion forums, making it a versatile tool for educators.

- Accessibility and Convenience: As a cloud-based platform, Brightspace can be accessed from anywhere, allowing for flexibility in learning and assessment. This is particularly beneficial for remote learning scenarios.
- Integration capabilities: Brightspace can be integrated with various third-party tools and platforms to enhance its functionality. This is useful for programming courses that may use a specific IDE or code repository.
- User-Friendly Interface: Brightspace is designed with a focus on user experience and is generally considered user-friendly, which is beneficial for students and teachers who are new to technology.
- Analytics and Reporting: The platform provides detailed analytics and reporting capabilities that can help teachers monitor student progress and identify areas where students may be struggling.

## **Brightspace Disadvantages**

- Limited real-world coding environment: Unlike your proposed solution, Brightspace does not inherently provide a real-world coding environment. It depends heavily on integration with other coding assessment tools.
- No standardised testing environment: Brightspace does not provide a standardised operating system or assessment environment, which can lead to inconsistent student experiences and possible differences in assessments.
- Potential for online resource usage: Since it is an online platform, there is a higher likelihood of students accessing unauthorised online resources during assessments unless specific proctoring tools are used.
- Dependence on Internet Connection: As an online restricted platform, Brightspace requires a reliable Internet connection, which may be in areas with poor Internet connectivity.
- Cost and Resource Requirements: Implementing and maintaining Brightspace can be costly and requires significant institutional resources, especially training and technical support.

In contrast, our solution offers a unique approach to delivering a standardised, real-world coding environment through a preconfigured operating system. This approach is more in line with practical programming scenarios, such as coding without Internet access and using a specific programming environment. However, it also requires physical presence and resources to set up and proctor. While Brightspace offers flexibility and broad functionality, it may not exactly replicate the specific needs of your coding environment as your solution does.

## **Summary of last week's activities and outcomes:**

### **Summary:**

Interviews with students and teachers were carefully analysed during last week's validation committee. Our conclusion is that it is feasible to use the Linux system to code the exam, although it is a brand new system, but we ensure that students will not cheat in the exam through network access settings and firewall settings. Compared with the traditional examination environment, online examinations, especially new examination systems, require users to spend time learning how to operate, because not only are the examination questions difficult, but the operating system is also difficult for people to become familiar with, which will affect the security of the examination. . It brings a lot of trouble to users during exams. A lot of pressure. But if we have a good practice platform that can provide students with programming exercises, then our software will be a good choice.

### **Outcome:**

The team modified the original plan into a more appropriate one, not only adding a more complete user page to prevent students from using the software if they were not familiar with the software environment. This prevents students from wasting time searching the internet for course-related topics. Early on, we not only allowed students to try our software in out-of-class exercises to verify the possibility of potential problems. At the same time, we can also use the exercise question mode to familiarise them with our pages, and professors can also collect knowledge points that students are not proficient in during exercises. In this way, professors do not need to waste time reviewing and reviewing familiar knowledge points for students during lectures. This week, we will begin to improve our Ubuntu Linux 20.04.2 version system and make the final deployment of our system. As the number of users gradually increases, potential problems during use are also discovered. In view of the expansion of the trial user group, we will also build a database and conduct random interviews with users as appropriate, which will lead

to time management of the team and distribution of tasks among personnel. Teams will first build more effective collaboration

## Current BMC + Validation Board

### Business Model Canvas of last week.

### Current BMC

The Business Model Canvas - Computer-based Programming Exam System - Plan A

<b>Key Partners</b>  <b>Educational institutions:</b> Establish partnerships with various schools and universities to provide them with examination services and get feedback and suggestions from them about the platform.  <b>Corporate entities:</b> Establish cooperative relationships with various companies to provide them with recruitment assessment services, and also obtain market trends and needs from companies.  <b>Cloud service provider:</b> Establish cooperative relationships with major cloud service providers to ensure stable operation of the system and safe storage of data.  <b>Third-party security company:</b> Cooperates with security companies to provide exam security monitoring and cheating detection to ensure the fairness and security of the exam.	<b>Key Activities</b>  <b>Platform development and maintenance:</b> Continuously develop new features, fix known issues, and optimize the platform.  <b>Marketing:</b> Conduct market research, understand customer needs, formulate and implement marketing strategies, and attract more potential users.  <b>Customer support and training:</b> Provide online and on-site customer support, as well as training for new users to ensure they can get the most out of the platform.  <b>Security monitoring:</b> Regularly check the security of the system to ensure data security and exam fairness.	<b>Value Propositions</b>  <b>Customized exam content:</b> Customers can customize the exam content and format according to their own needs.  <b>Advanced anti-cheating technology:</b> Use the latest monitoring and analysis technology to ensure exam integrity.  <b>Automated scoring:</b> Automate scoring of programming questions and objective questions, greatly reducing the burden on teachers and raters.  <b>Detailed Analysis Reports:</b> Provides teachers and institutions with detailed student performance reports to help them understand students' strengths and weaknesses.  <b>Practice Sessions:</b> Provides the users Practice sessions to work on, which can be updated by the uploader.  <b>Review Sessions:</b> Based on the practice session / test results, the professors can help students review the topics they don't understand.  <b>Improved features:</b> Provides boot safe OS in the USB and further improved features for customers subscribed for more than a certain amount of time. ( Tier-Based ).	<b>Customer Relationships</b>  <b>Online support:</b> Provide real-time online help and technical support to ensure the smooth progress of the exam.  <b>Regular feedback meetings:</b> Communicate regularly with customers to understand their needs and suggestions and continuously improve services.  <b>24/7 Helpline:</b> In addition to online support we also include a 24/7 helpline for the smooth progression of exams.	<b>Customer Segments</b>  <b>Educational institution:</b> School: From elementary school to high school, midterm, final, or other standardized tests are required.  <b>Universities and Colleges:</b> Provide students with regular semester exams or laboratory tests. Vocational training and adult education centers: Provide platforms for short courses or vocational qualification examinations.  <b>Technology companies:</b> Conduct coding or technical interview assessments.  <b>Non-technical companies:</b> Conduct logical, mathematical or other non-technical related assessments.  <b>Independent certification body:</b> An organization that certifies individuals in skills or qualifications, such as project management, IT service management.
<b>Cost Structure</b>  <b>Fixed costs:</b> <ul style="list-style-type: none"><li>- Development and Maintenance: developing the OS and maintaining it.</li><li>- USB: Cost of USB sticks and uploading OS in each stick</li><li>- Cloud service fee: Basic cloud computing and storage fees.</li><li>- Employee Compensation: Wages and benefits for your team.</li></ul> <b>Variable costs:</b> <ul style="list-style-type: none"><li>- Third-party service fees: such as payment gateways, security checks, or other integrated services.</li><li>- Marketing and Advertising: Varies based on marketing campaigns and promotional strategies.</li></ul>	<b>Revenue Streams</b>  <b>Hardware:</b> The USB sticks are sold as per the need of the customer with discounts based on the number of USB sticks bought.  <b>Subscription:</b> The app is a subscription-based model which gives access to tools that can help monitor each student's progress			

# Updated BMC

## The Business Model Canvas - Computer-based Programming Exam System - Plan A

<b>Key Partners</b>	<b>Key Activities</b>	<b>Value Propositions</b>	<b>Customer Relationships</b>	<b>Customer Segments</b>
<b>Educational Institutions:</b> Establish partnerships with various schools and universities to provide them with examination services and get feedback and suggestions from them about the platform.  <b>Corporate entities:</b> Establish cooperative relationships with various companies to provide them with recruitment assessment services, and also obtain market trends and needs from companies.  <b>Cloud service provider:</b> Establish cooperative relationships with major cloud service providers to ensure stable operation of the system and safe storage of data.  <b>Third-party security company:</b> Cooperate with security companies to provide exam security monitoring and cheating detection to ensure the fairness and security of the exam.	<b>Platform development and maintenance:</b> Continuously develop new features, fix known issues, and optimize the platform.  <b>Marketing:</b> Conduct market research, understand customer needs, formulate and implement marketing strategies, and attract more potential users.  <b>Customer support and training:</b> Provide online and on-site customer support, as well as training for new users to ensure they can get the most out of the platform.  <b>Security monitoring:</b> Regularly check the security of the system to ensure data security and exam fairness.	<b>Customized exam content:</b> Customers can customize the exam content and format according to their own needs.  <b>Advanced anti-cheating technology:</b> Use the latest monitoring and analysis technology to ensure exam integrity.  <b>Automated scoring:</b> Automatic scoring of programming questions and objective questions, greatly reducing the burden on teachers and raters.  <b>Detailed Performance analysis:</b> Provides teachers and institutions with detailed student performance analytics reports and personal performance analytics dashboard.	<b>Online support:</b> Provide real-time online help and technical support to ensure the smooth progress of the exam.  <b>Regular feedback meetings:</b> Communicate regularly with customers to understand their needs and suggestions and continuously improve products.  <b>24/7 Helpline:</b> In addition to online support we also include 24/7 helpline for the smooth progression of exams.	<b>Educational institution:</b> School: From elementary school to high school, midterm, final, or other standardized tests are required.  <b>Universities and Colleges:</b> Provide students with regular semester exams or laboratory tests. Vocational training and adult education centers: Provide platforms for short courses or vocational qualification examinations.  <b>Technology companies:</b> Conduct coding or technical interview assessments.  <b>Non-technical companies:</b> Conduct logical, mathematical or other non-technical related assessments.  <b>Independent certification body:</b> An organization that certifies individuals in skills or qualifications, such as project management, IT service management.
<b>Cost Structure</b>	<b>Key Resources</b>	<b>Channels</b>		
<b>Fixed costs:</b> <ul style="list-style-type: none"> <li>- Development and Maintenance: developing the OS and maintaining it.</li> <li>- USB: Cost of USB sticks and uploading OS in each stick</li> <li>- Cloud service fee: Basic cloud computing and storage fees.</li> <li>- Employee Compensation: Wages and benefits for your team.</li> </ul> <b>Variable costs:</b> <ul style="list-style-type: none"> <li>- Third-party service fees: such as payment gateways, security checks, or other integrated services.</li> <li>- Marketing and Advertising: Varies based on marketing campaigns and promotional strategies.</li> </ul>	<b>Technology Infrastructure</b> : To Handle the servers and database that host the tests.  <b>Customer Support team</b> : To help the customers with their queries or receive feedback and reply to the customers	<b>Online demonstration:</b> Provide online product demonstrations and introductions through the website to let potential customers understand the functions and advantages of the product.  <b>Practice Sessions:</b> Provides the users Practice sessions to work on, which can be updated by the uploader.  <b>Review Sessions:</b> Based on the practice session / test results, the professors can help students review the topics they don't understand.  <b>Improved features:</b> Provides boot safe OS in the USB and further improved features for customers subscribed for more than a certain amount of time. ( Tier-Based ).  <b>Sales Team:</b> Establish a professional sales team to communicate directly with potential customers and understand their needs.  <b>Partners and Agents:</b> Work with education technology companies and other agents to expand market reach.  <b>Social Media and Advertising:</b> Run advertising and promotional campaigns on social media platforms to attract more potential customers.		
		<b>Revenue Streams</b>		
		<b>Hardware:</b> The USB sticks are sold as per the need of the customer with discounts based on the number of USB sticks bought.  <b>Subscription:</b> The app is a subscription-based model which gives access to tools that can help monitor each student's progress		

### Value Propositions:

Added a personal performance analysis dashboard for students and users to review. This personal performance dashboard provides users with the graphs that shows their Strength and weaknesses and helps them improving in their subject

### Plan for this week:

In our solution, we aim to better understand students' acceptance of online programming exam software and gather their feedback to optimise our product.

Familiarise students with our system. Through this process, we are able to gather their feedback and identify potential issues that may exist.

To better understand the needs and expectations of students and professors, we will conduct a series of user interviews. We will ask them the following questions:

**Management:**

**An assessment of current programming skills assessment methods:**

"Can you share your insights into the effectiveness of current methods for assessing students' programming skills? Are there any specific challenges you encounter when using these methods, particularly in maintaining academic integrity and accurately assessing actual coding ability?"

**Interested in enhancing practical coding assessment:**

"How important is it for your institution to provide students with a more authentic, practical coding environment during assessment? Do you think this approach will better prepare them for real-world programming challenges?"

**Openness to technological innovation and collaboration:**

"Is the university actively seeking new technology solutions to enhance the learning and assessment experience for engineering students? How open are you to working with external partners to pilot innovative educational technologies?"

**Student:**

**Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

**Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools,

compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

We will collect and analyse feedback from students and professors, from which we will be able to better understand their needs so that we can optimise our software and provide a better user experience. At the same time, we will also actively contact universities. In future plans, we will consider adding interviews with technical staff so that our software can be used in midterm or final exams. We will demonstrate the strengths of our software and our efforts to resolve potential issues to ensure the exam is fair and runs smoothly.

While these activities are ongoing, our team will continue to design and optimise web pages to ensure user-friendliness and feasibility. We will continually test and improve our software to ensure it meets the needs of students, professors, and educational institutions.

As we execute our plans, we will remain flexible and adjust our action plans based on student and professor feedback and our observations to better achieve our goals. Our team will work together to ensure every step goes according to plan to ensure our software can be successfully implemented into online programming exams and provide a better educational experience.

This week's core assumption and why:

The core premise of this week is that by completing the entire software to improve our system and providing practice pages for students to practise programming languages on our platform, we can help them become more familiar with our system, improve their programming skills, and save money. Search the Internet for course times on related topics. We also hypothesised that by allowing professors to collect data on knowledge points that students struggle to master, we could help them better tailor lectures to students' needs.

The reason for this assumption is based on feedback we received from students and professors who have used our system in the past. Many expressed a desire for more opportunities to practise and learn on the platform and suggested that a practice page would be a valuable addition. Additionally, professors expressed a desire for more data on student performance so they can better understand student needs and adjust their teaching methods accordingly. By meeting these needs, we believe we can provide students and professors with a more valuable and user-friendly platform.

## Validation Methods and Why:

### 1. Interview:

Conduct one-on-one interviews with students and teachers from the engineering department to inquire in detail about their feelings and needs for online programming exam software.

Why: In-depth interviews can provide detailed and rich feedback to help us understand the true needs, pain points and expectations of target users.

### 2. Questionnaire:

Design an online questionnaire to ask participants about their needs and preferences for online programming exam software.

Why: Questionnaires can collect data on a large scale, provide feedback in a broader and statistical sense, and help us better understand the overall needs of the market.

### 3. Prototype Testing (Later):

Develop a basic online programming exam software prototype, invite students and teachers to try it out, and collect their feedback.

Why: By interacting with real users, we can directly observe how they use the software, understand whether the software's features meet their needs, and make improvements based on feedback.

**Results (all data, including interview transcripts, must include in an appendix, only include the processed result directly in your report, we need 10 interviews to earn full mark):**

No #	Gender	Program	Year	Comments	Validation
1	Male	Faculty of Engineering	Management	Acknowledge the limitations of their current assessment methods, particularly in terms of effectively measuring practical coding skills and ensuring academic integrity, particularly in remote areas.	Yes

				They showed a strong interest in more realistic coding environments to help students better cope with real-world challenges. The Dean is also willing to work with external technology partners to enhance the educational experience.	
2	Male	Faculty of Engineering	Management	feels that their current assessment methods are somewhat effective, but recognizes that improvements are needed, particularly in balancing theoretical knowledge with practical application. They emphasise the importance of practical coding assessments to meet industry needs and are very willing to explore new technologies that can enhance courses and assessment methods.	Yes
3	Male	Faculty of Engineering	Management	Feel that their current methods do not fully capture the practical aspects of programming, such as debugging and optimization in real-world settings. They emphasise the importance of practical skills complementing theoretical knowledge and actively seek innovative solutions to enhance teaching and assessment methods.	Yes
4	Female	Faculty of Engineering	Management	Noted that their traditional approach can limit programming, as students tend to excel in theory but not in practice. They consider integrating practical	Yes

				assessments, which are critical to a comprehensive understanding of programming and aligning courses with industry standards. They expressed interest in exploring new approaches, including technology solutions, to improve the quality of education while maintaining academic integrity.	
5	Male	Computer Science	Student	finds current online tests to be inadequate for testing practical coding skills, focusing more on theoretical knowledge. They express a clear preference for a hands-on approach to assessments, seeing it as a better measure of real-world problem-solving abilities	Yes
6	Male	Computer Science	Student	comfortable with the traditional format of online quizzes and written exams due to their straightforward nature. However, they express apprehension about the proposed realistic coding environment, fearing it might be more complicated and stressful.	Yes
7	Female	Computer Science	Student	struggles with translating coding skills into written answers and finds practical tasks more suitable. They believe that a realistic coding environment would significantly improve their ability to demonstrate actual coding capabilities.	Yes

8	Female	Computer Science	Student	feels current exams are okay but not very relevant to real programming tasks like debugging and writing code. They are very enthusiastic about the idea of a more practical and relevant exam format	Yes
9	Male	Software Engineering	Student	He is okay with written exams but feels they focus more on memorization rather than understanding. They are curious about the new approach but have some scepticism about how it would work under exam conditions.	Yes
10	Female	Computer Science	Student	considers the current system outdated and not challenging enough in terms of real coding skills. They view the proposed approach as a great idea that would make assessments more meaningful and aligned with real-life programming challenges.	Yes

Reflections must be included in all changes made to justify and analyse the consequences:

- Validation Board:

		Validation Board										
Project Name: _____		Team Leader Name: _____										
Track Pivots		Start	1st Pivot	2nd Pivot	3rd Pivot	4th Pivot						
Customer Hypothesis		Tip: For two-sided notes write first side first	Educational Institutions Corporate entities									
Problem Hypothesis			Code is written on paper with no compiler									
Solution Hypothesis			Tip: Do NOT define a solution until you've validated the problem									
Design Experiment		<p><b>Riskiest Assumption</b> Students don't enjoy writing code on paper <small>Let's work on this assumption</small></p> <p><b>Core Assumptions</b></p> <table border="1"> <tr> <td>Students bring their own laptop</td> <td>Professors are comfortable with software</td> <td>Main exams carried in software</td> </tr> <tr> <td>Students value privacy more</td> <td></td> <td></td> </tr> </table> <p><b>Results</b> →</p> <p><b>GET OUT OF THE BLDG</b></p> <p>By means of interviewing people</p> <p>6/10</p>					Students bring their own laptop	Professors are comfortable with software	Main exams carried in software	Students value privacy more		
Students bring their own laptop	Professors are comfortable with software	Main exams carried in software										
Students value privacy more												
		Invalidated			Validated							
		Pivot at least one Core Hypothesis	1	2	1	2						
		Students bring their own laptop	Main exams carried in software	Students don't enjoy writing code on paper	Professors are comfortable with software							
		3	4	3	4							
		5	6	5	6							

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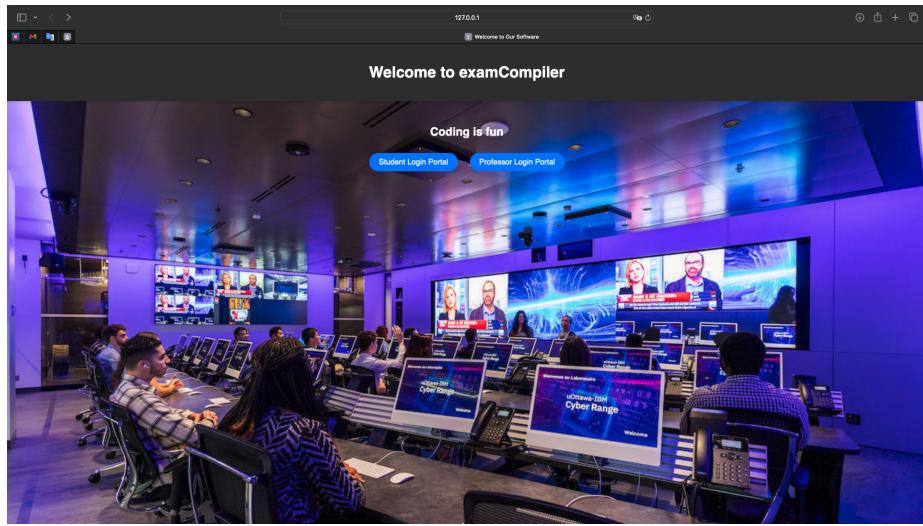
- Updated Validation Board:

		Validation Board										
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Track Pivots		Start	1st Pivot	2nd Pivot	3rd Pivot	4th Pivot						
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- Update prototype

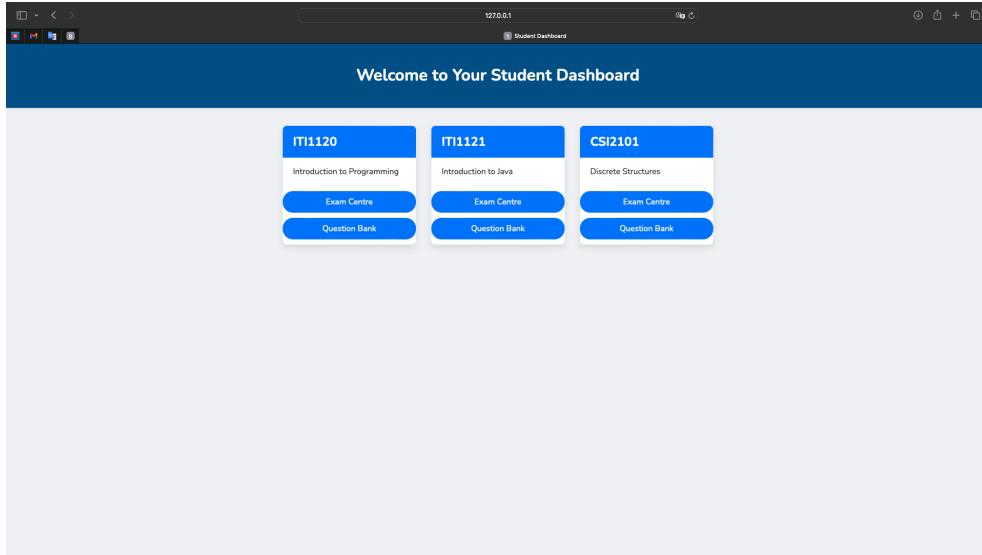


I create a welcome interface for a software or service named "examCompiler" login link: There are two button links in the middle part of the page. The first one is "Student Login Portal", students can click this button to enter the login page; the second one is "Professor Login Portal", professors or lecturers can click this button to enter their login page. These two buttons change colour and display shadows on mouseover, enhancing the user experience.

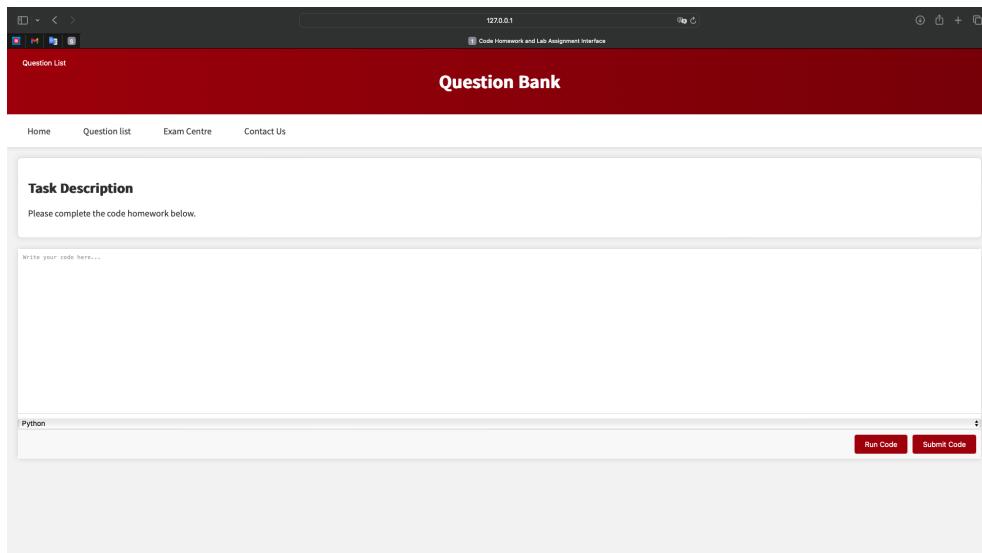
A screenshot of a web browser displaying the "Student Login Portal" page. The page features a large background image of a control room with multiple people working at desks with computer monitors. To the right of the image is a login form titled "Student Login Portal". The form includes fields for "Email Address" and "Password", with a "Remember me" checkbox below the password field. Below the form is a blue "SIGN IN" button. At the bottom of the page, there is a small link "Forgot password?" and a copyright notice "Copyright © examCompiler 2023".

The user enters their email and password into two input boxes and then clicks the "SIGN IN" button to log in. If a user checks the "Remember me" checkbox, their login information may be saved so it can be auto-populated the next time they visit. When the user clicks the "SIGN IN" button, the JavaScript code on the web page will be executed, causing the page to jump to

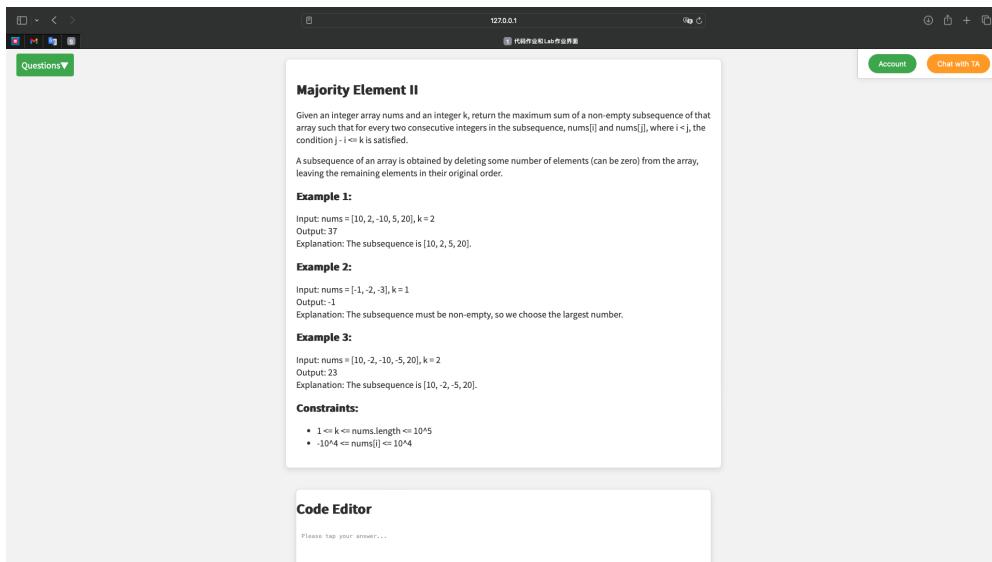
another page named "file.html". This means users will be redirected to the page they should see after logging in. If a user forgets their password, they can click on the "Forgot password?" link to begin the password recovery or reset process.



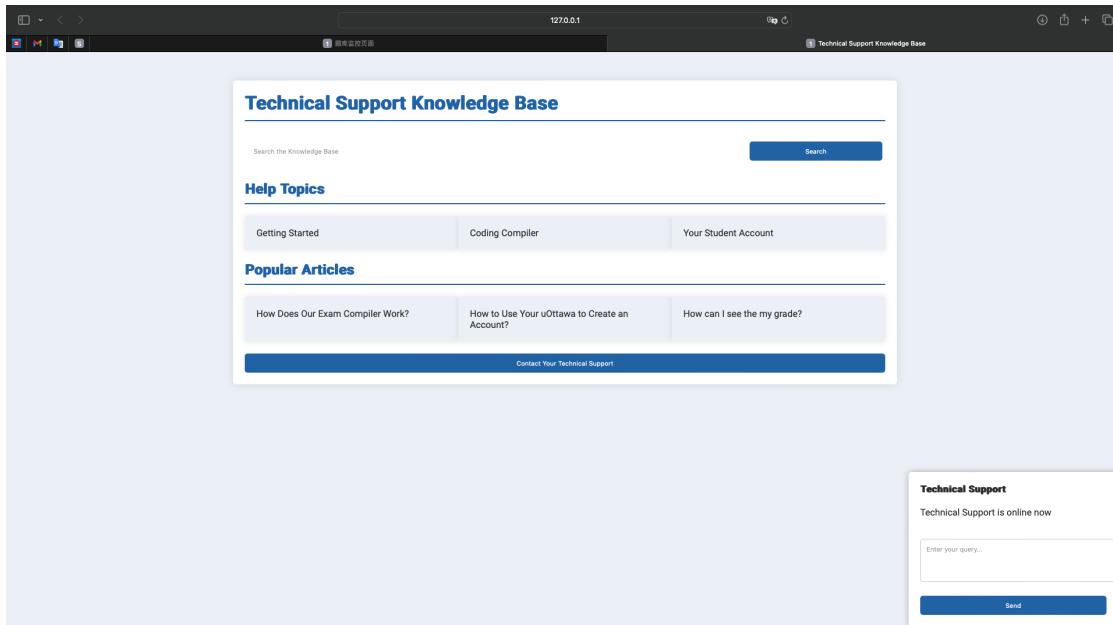
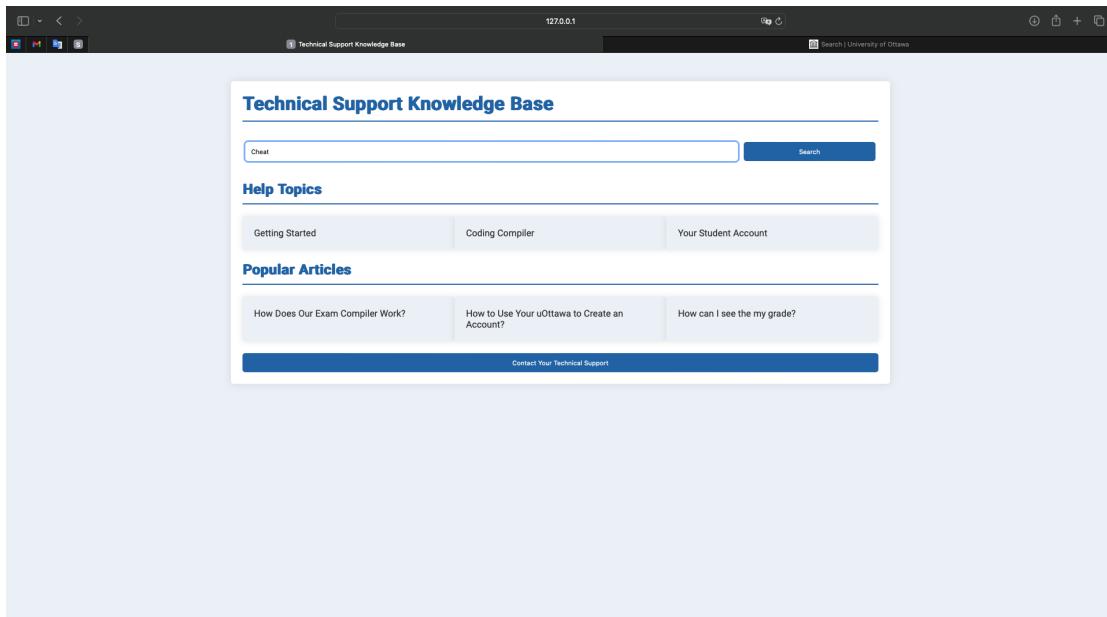
This webpage is a student dashboard (Dashboard), just like the homepage of an online learning platform. The courses students are studying are listed here. Each course card contains the course name and a brief course introduction. For example, there is a course called "ITI1120", with "Introduction to Programming" written below as an introduction. Each card also has two button links, one is "Test Center" and the other is "Question Bank". Students might click on these buttons to do after-class exercises or take online exams.

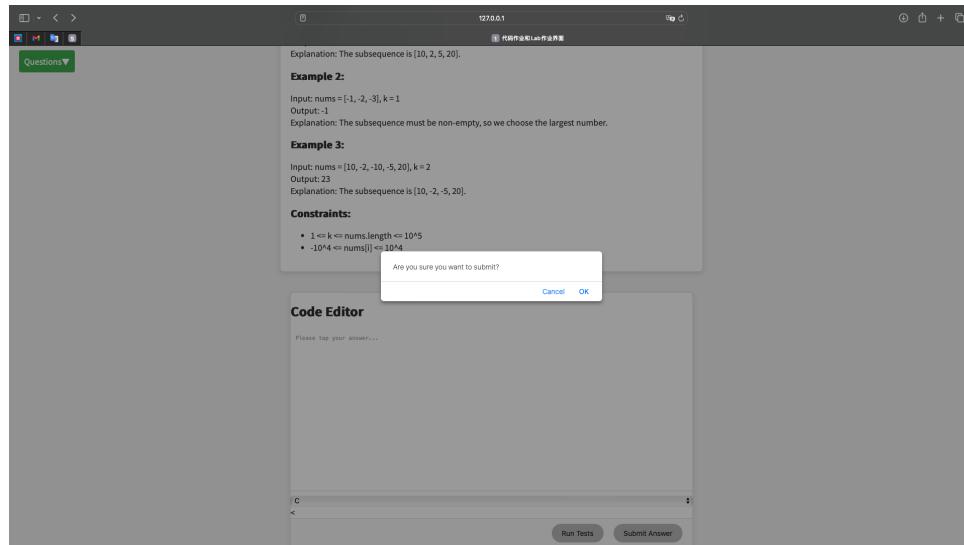
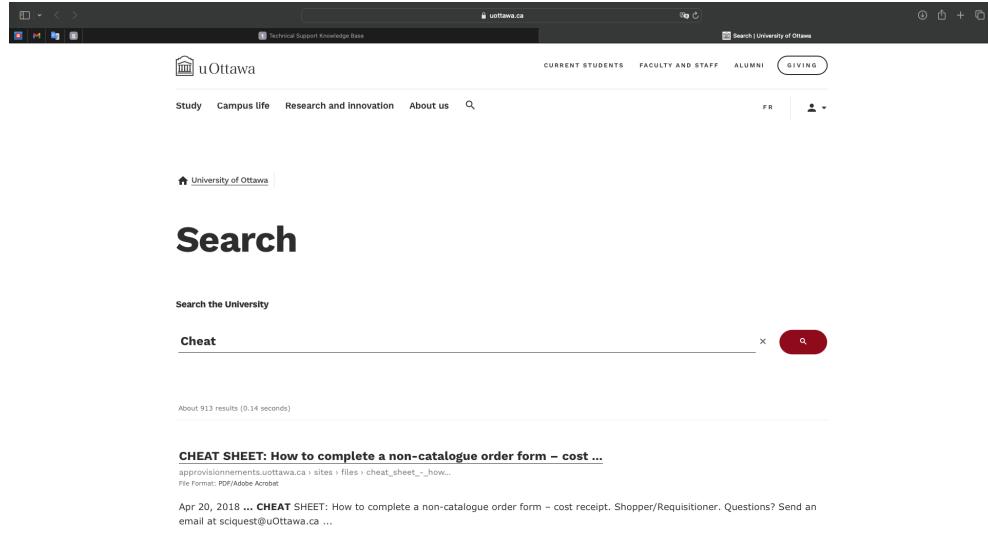


The Question Bank navigation bar provides four links: Home Page, Question List, Test Center and Contact Us. These links may lead to other related pages, but the destination of these links is not defined in detail in this code. There is a title "Task Description" and a short text description that prompts the user to complete the coding task below. This is the main area where users can write and edit code. It includes a large text box and a drop-down menu that allows the user to select a different programming language (such as Python, JavaScript, or Java). There are two buttons at the bottom: "Run Code" and "Submit Code" that allow users to test and submit their code. There is a clickable button "Question List" on the page. Clicking this button will show or hide a list of different questions. Each question is marked with a difficulty level (e.g. "Medium") to help users understand how difficult each question is.



This is a button at the top of the page that shows or hides the list of questions. Clicking this button will bring up a list of different programming topics. Question List (questionList): This list shows different programming questions, each with a difficulty level (such as "Part1", "Part2", etc.). Account and Chat buttons (accountAndChat): There are two buttons in the upper right corner of the page. One is "Account", which is used to jump to the user account page; the other is "Chat with TA", which is used to open a chat window with the teaching assistant. Task Description area (taskDescription): This area describes the selected programming topic in detail. Include background information of the topic, specific requirements, input and output examples, and constraints. Code Editor: This is where users write code. This is where users can enter their code answers. Also included is a drop-down menu that allows users to select a programming language (such as C, C++, Java, etc.). Run Tests and Submit Answer buttons: Below the code editor, there are two buttons: "Run Tests" for testing the code, and "Submit Answer" for submitting answers. Before submitting the answer, there will be a confirmation prompt box asking the user if they really want to submit.





**Search function:** There is a search bar at the top of the page where users can enter keywords to search the knowledge base. After entering the content, click the "Search" button, and the search results will be displayed on the University of Ottawa website in a new tab.

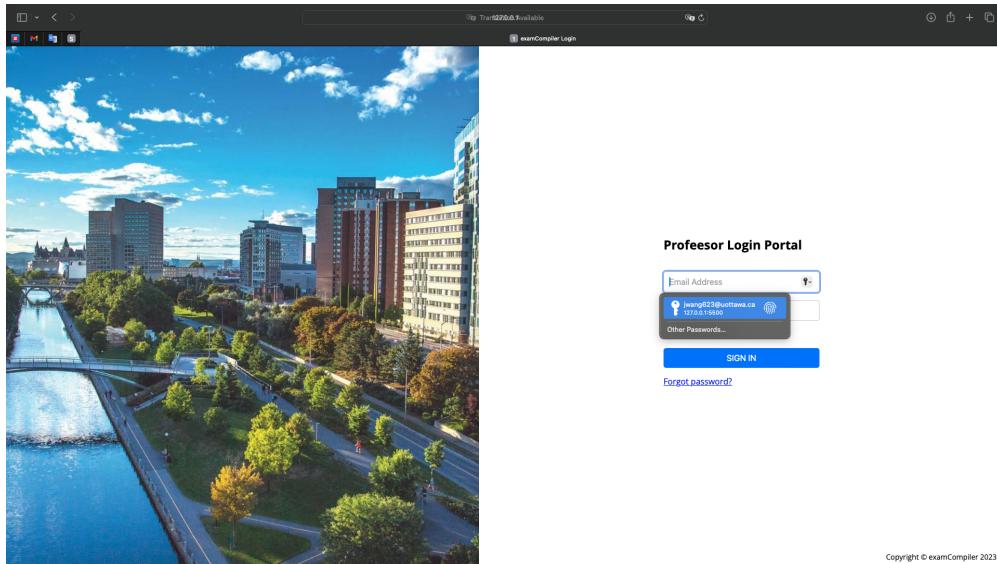
**Help topic area:** There is a "Help Topics" area below, which lists three topics: "Getting Started" (Getting Started), "Coding Compiler" (Programming Compiler), "Your Student Account" student account). These appear to be clickable links to related help articles or guides.

**Popular articles area:** Next is the "Popular Articles" area, which lists three articles, which may be answers to user FAQs or user guides.

**Contact technical support button:** There is a button at the bottom of the page, which when clicked will open a chat box for users to communicate with technical support personnel.

**Chat box:** The chat box is initially hidden. When the user clicks the "Contact Your Technical Support" button, it will appear in the lower right corner of the page. There is a line of text in the chat box.

showing the online status of technical support (initially "Checking online status...", that is, "Checking online status...", and then changes to "Technical Support is online now", that is, "Technical Support Currently online"). Users can type questions into the text area of the chat box and click the "Send" button to send the message. If the user attempts to send without entering anything, a prompt will pop up asking for a message.



This page is a login interface designed for professors to log into their portal. Here are its main features and functions: There is a title “Professor Login Portal”. Includes two input fields: one for professors to enter their email address, and one for their password. There is also a checkbox that lets users choose whether they want their login information to be remembered. There is a button "SIGN IN" for submitting login information. There is also a link to retrieve a forgotten password.

Name	Exam Status	Screen
Student 1	Online	
Student 2	Offline	
Student 3	Online	
Student 4	Offline	
Student 5	Offline	
Student 6	Offline	
Student 7	Offline	

**Title and Navigation Bar:** At the top of the web page is a title bar that displays the title "Exam Monitoring Dashboard". There is a navigation bar below that provides four links: Dashboard, Students, Exams, and Settings. These links help users jump to different page sections quickly.

**Dashboard Section:** This section shows the number of students currently online and the number of exams in progress. Other information related to exam monitoring may also be included, although this information is not specifically shown in the provided code.

**Student Section:** This displays a table listing the student's name, exam status (such as online or offline), and a placeholder image showing the student's computer screen. This feature may be used to monitor students' computer screens in real time to ensure the fairness of exams.

**Settings section:** In this section, users can adjust notification settings. Three sensitivity options are available: "High Sensitivity", "Medium Sensitivity" and "Low Sensitivity". This may be used to control alert levels for unusual behaviour during exams.

The screenshot shows a web application interface titled "Monitoring" with a red header bar containing links for Main, Monitoring, Student List, and Technical Support. Below the header is a grid of 17 question cards arranged in four rows. Each card has a title and a "CorrectRate:" value.

Majority Element II	Integer Break	Palindrome Linked List	First Bad Version	Invert Binary Tree
CorrectRate: 70%	CorrectRate: 80%	CorrectRate: 75%	CorrectRate: 85%	CorrectRate: 90%
Two Sum	Add Two Numbers	Longest Substring Without Repeating Characters	Median of Two Sorted Arrays	Regular Expression Matching
CorrectRate: 95%	CorrectRate: 60%	CorrectRate: 80%	CorrectRate: 70%	CorrectRate: 60%
3Sum	Container With Most Water	Integer to Roman	Roman to Integer	Longest Palindromic Substring
CorrectRate: 85%	CorrectRate: 75%	CorrectRate: 70%	CorrectRate: 80%	CorrectRate: 90%
Zigzag Conversion	Reverse Integer	String to Integer (atoi)	Palindrome Number	Regular Expression Matching
CorrectRate: 85%	CorrectRate: 90%	CorrectRate: 85%	CorrectRate: 80%	CorrectRate: 75%
Container With Most Water CorrectRate: 70%				

This web page is a monitoring system called "Question Bank Monitoring Page", which is mainly used to display the accuracy statistics of different questions.

## Conclusion and Next Steps:

Overall, our prototype clearly exceeded the limitations of the Brightspace platform. Over the past week, we have produced a significant update to the BMC through extensive research and interviews with potential stakeholders, including students. Specifically, with the addition of Boot Secure OS to USB to further protect user privacy and improve functionality based on customers' subscription time we also updated the personal dashboard of users with performance analytics

related to that user that provided a better description of the user's work over the period of using the software.

In addition, we refined the prototype to include new features and improvements to existing features, such as adding a better login page and controlling traffic to the Moodle server. Further steps can be taken to prevent illegal data transfers by managing the network interface through nmcli, disabling all wireless connections, and adding configuration files in /etc/modprobe. These interviews showed us that there was a demand for our product because it solved many of the problems present in current market solutions while also allowing students to compile code electronically and test their coding. This is more applicable to real world situations and work environments.

Our next steps include testing the feasibility of the current iteration of the prototype, improving it, and potentially creating different iterations that are more user-friendly and easy to navigate. The monitor's web pages have been further designed to ensure students complete their exams without cheating. We also plan to incorporate stakeholder feedback and take their concerns into account as we further develop the prototype. This will help us validate our assumptions and core assumptions in the coming weeks.

## **APPENDIX:**

### **Interview 1:**

#### **An assessment of current programming skills assessment methods:**

"Can you share your insights into the effectiveness of current methods for assessing students' programming skills? Are there any specific challenges you encounter when using these methods, particularly in maintaining academic integrity and accurately assessing actual coding ability?"

We've relied mainly on traditional written exams and some computer-based tests. While they serve their purpose, we often struggle with adequately assessing practical coding skills. There's also the constant challenge of ensuring academic integrity in remote settings

#### **Interested in enhancing practical coding assessment:**

"How important is it for your institution to provide students with a more authentic, practical coding environment during assessment? Do you think this approach will better prepare them for real-world programming challenges?"

Practical skills are crucial in engineering. We're increasingly aware that our current methods might not fully prepare students for real-world challenges. There's definitely an interest in more realistic coding environments.

**Openness to technological innovation and collaboration:**

"Is the university actively seeking new technology solutions to enhance the learning and assessment experience for engineering students? How open are you to working with external partners to pilot innovative educational technologies?"

We're always looking for ways to improve. Collaborating with external tech partners is something we're open to, especially if it can provide a tangible benefit to our students' learning experience.

**Interview 2:**

**An assessment of current programming skills assessment methods:**

"Can you share your insights into the effectiveness of current methods for assessing students' programming skills? Are there any specific challenges you encounter when using these methods, particularly in maintaining academic integrity and accurately assessing actual coding ability?"

Our methods are somewhat effective, but there's room for improvement. The biggest issue is creating a balance between theoretical understanding and practical application, especially in a controlled exam setting

**Interested in enhancing practical coding assessment:**

"How important is it for your institution to provide students with a more authentic, practical coding environment during assessment? Do you think this approach will better prepare them for real-world programming challenges?"

It's essential. The industry demands coders who can solve real problems, not just write code on paper. I believe a more hands-on assessment approach is necessary."

**Openness to technological innovation and collaboration:**

"Is the university actively seeking new technology solutions to enhance the learning and assessment experience for engineering students? How open are you to working with external partners to pilot innovative educational technologies?"

Innovation is at the heart of computer science. We're very much open to exploring new technologies that can enhance our curriculum and assessment methods

**Interview 3:****An assessment of current programming skills assessment methods:**

"Can you share your insights into the effectiveness of current methods for assessing students' programming skills? Are there any specific challenges you encounter when using these methods, particularly in maintaining academic integrity and accurately assessing actual coding ability?"

Our current methods are good, but they don't fully capture the essence of programming. We often miss out on testing important skills like debugging and code optimization in a real environment

**Interested in enhancing practical coding assessment:**

"How important is it for your institution to provide students with a more authentic, practical coding environment during assessment? Do you think this approach will better prepare them for real-world programming challenges?"

Absolutely important. Theoretical knowledge needs to be complemented with practical skills. Students should experience what it's like to code in a real-world setting."

**Openness to technological innovation and collaboration:**

"Is the university actively seeking new technology solutions to enhance the learning and assessment experience for engineering students? How open are you to working with external partners to pilot innovative educational technologies?"

Adopting new technologies is key to staying relevant in education. We're always on the lookout for innovative solutions that can enhance our teaching and assessment methodologies

#### **Interview 4:**

##### **An assessment of current programming skills assessment methods:**

"Can you share your insights into the effectiveness of current methods for assessing students' programming skills? Are there any specific challenges you encounter when using these methods, particularly in maintaining academic integrity and accurately assessing actual coding ability?"

Our current approach is somewhat traditional and could be limiting in terms of programming. We often find that students excel in theoretical aspects but struggle in practical scenarios.

##### **Interested in enhancing practical coding assessment:**

"How important is it for your institution to provide students with a more authentic, practical coding environment during assessment? Do you think this approach will better prepare them for real-world programming challenges?"

Integrating practical assessments is vital for a comprehensive understanding of programming. It's something we've been considering to better align our curriculum with industry standards

##### **Openness to technological innovation and collaboration:**

"Is the university actively seeking new technology solutions to enhance the learning and assessment experience for engineering students? How open are you to working with external partners to pilot innovative educational technologies?"

We are definitely interested in exploring new methods, including technological solutions. Our focus is on enhancing the quality of education while maintaining academic integrity.

#### **Interview 5:**

##### **Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

I find the current online tests quite limiting. They don't really challenge my actual coding skills, just my theoretical knowledge. I often feel like I'm not being tested on the real skills I need as a programmer

**Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools, compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

**I'd definitely prefer a more hands-on approach. It sounds like a great way to test our ability to solve real-world problems, not just answer multiple-choice questions.**

**Interview 6:**

**Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

Honestly, I'm comfortable with the way things are. I'm used to the format of online quizzes and written exams. They're straightforward and predictable.

**Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools, compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

It sounds interesting, but I'm a bit apprehensive. It seems like it could be more complicated and stressful, especially under exam conditions.

### **Interview 7:**

#### **Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

I struggle with the current format. Translating my coding thoughts into written answers isn't easy for me. I do better with practical tasks.

#### **Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools, compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

This approach would be a game-changer for me. It's much closer to what I do during my internships and personal projects. I'd be able to showcase my actual coding abilities.

### **Interview 8:**

#### **Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

I find the current exams okay but not very relevant. They don't capture the essence of programming, like debugging and actually writing code.

#### **Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools, compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

I think it's a brilliant idea! It would make exams more relevant and interesting. I'm all for it.

## **Interview 9:**

### **Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

I'm okay with the written exams, but they sometimes feel disconnected from the practical skills we need in the job market. It's more about memorising than understanding.

### **Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools, compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

I'm curious but slightly sceptical. How will it work under exam conditions? If it's well-implemented, it could be beneficial

## **Interview 10:**

### **Current programming assessment experience:**

"Can you describe your experience with the current methods used for programming assessments? What aspects do you find beneficial and what challenges or limitations have you encountered, particularly in terms of the practicality and realism of these assessments?"

The current system is a bit outdated. It doesn't really challenge me in the way actual coding does. There's a gap between what we're tested on and what we need to know

### **Interested in a more realistic coding environment for exams:**

"What do you think about taking a programming exam in a more realistic coding environment, such as one delivered by a preconfigured operating system with a variety of programming tools, compared to a traditional written test or online multiple-choice exam? What do you think? Which of these methods better reflects your coding skills and knowledge?"

I think it's a great idea. It would prepare us better for real-life programming challenges and make the assessment more meaningful