

Co-funded by the  
Erasmus+ Programme  
of the European Union



TrustID 

University of Cyprus Multiplier Event  
Intellectual Output 3 - Evaluation Reports regarding Efficiency,  
Effectiveness and User Acceptance of TRUSTID in Three Case Studies  
at Higher Education Institutions across Europe

Dr. Argyris Constantinides, University of Cyprus



University  
of Cyprus



**cognitiveux**

# Intellectual Output 3 (IO3)

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Evaluation Reports regarding Efficiency, Effectiveness and User Acceptance of TRUSTID in Three Case Studies at Higher Education Institutions across Europe
- *Lead:* University of Cyprus
- *Participating Partners:*
  - University of Patras
  - Cognitive UX GmbH
  - University of Coimbra ISR
- *Output type:* Studies / analysis – Data collection / analysis
- *Media:* Dataset, Publications

# IO3 – Key Objectives

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Organize and execute **standalone studies and pilot trials**
- **Assess the effectiveness and accuracy** of the intelligent biometric methods
- Evaluate the overall effect of the project on **usability and security**
- Produce **evaluation reports**
- **Define personas** including the characteristics of the most representative end-users
- **Define different evaluation scenarios** of TRUSTID

# IO3 - Tasks and Task Leaders

Co-funded by the  
Erasmus+ Programme  
of the European Union



- **Task 3.1: Design of Experimental Evaluation Methodology**
  - **Lead: University of Patras**
  - *Participating:* University of Cyprus, Cognitive UX GmbH, University of Coimbra
- **Task 3.2: Formative Evaluation Report**
  - **Lead: University of Cyprus**
  - *Participating:* University of Patras, Cognitive UX GmbH, University of Coimbra
- **Task 3.3: Summative Evaluation Report**
  - **Lead: University of Cyprus**
  - *Participating:* University of Patras, Cognitive UX GmbH, University of Coimbra

## Task 3.1: Design of Experimental Evaluation Methodology

Co-funded by the  
Erasmus+ Programme  
of the European Union



- **Design the overall experimental methodology** to be followed throughout the course of the project
- **Ecological validity** (design a study that approximates the real-life contexts)
  - Design a series of user studies in which real users will be performing real-life tasks in their natural environment
- Studies with **balanced** gender (male/female), students, faculty and administrative staff of the University of Patras, the University of Cyprus and the University of Coimbra
- Two types of studies
  - **Formative**, conducted at early stages of the project, which aim at validating initial prototypes of the platform and get initial user feedback on likeability, perceived usability and security
  - **Summative**, conducted during the last months of the project to evaluate the effectiveness and feasibility of the proposed approach

## Task 3.2: Formative Evaluation Report

Co-funded by the  
Erasmus+ Programme  
of the European Union



- On completion of the low-fidelity development, we will conduct studies with semi-structured interviews to gather **qualitative user feedback for the low-fidelity release**
  - Based on feedback gathered from the previous cycle, we will refine IO1 and IO2
- Upon completion of the second round of development, we will conduct another round of studies to:
  - investigate whether the proposed system **improves identity and authentication usability and security**
  - evaluate **user acceptance** with Technology Acceptance Models to validate the developed user identification schemes

## Task 3.3: Summative Evaluation Report

Co-funded by the  
Erasmus+ Programme  
of the European Union



- We will conduct the final evaluation aiming to **evaluate usability and user acceptance** of the proposed platform
- Various metrics will be measured, which will focus on capturing **qualitatively and/or quantitatively** the user's perceived usability and security, likeability and user acceptance
- The measurements will be collected through **user feedback** (e.g., post-study questionnaires, interviews), and by examining **user interaction patterns** during user identification through user tracking equipment (e.g., Web cameras, eye trackers)

# User Study Scenarios for Proof of Concept 2



# Aims of the Evaluation

Co-funded by the  
Erasmus+ Programme  
of the European Union



We conducted a user study aiming to evaluate:

- i) the resilience of TRUSTID to impersonation attacks during an online examination by evaluating the implemented face- and voice-based identification mechanism;
- ii) usability and user experience of end-users based on their interactions with the TRUSTID system; and
- iii) perceived security and privacy of users towards the TRUSTID system

# Study Design 1/2

Co-funded by the  
Erasmus+ Programme  
of the European Union



## Type of study

- Studies are held virtually
  - Researchers from each partner HEI communicate with the participants through an off-the-shelf communication tool, Zoom

## Sample size, user profiles and duration

- Recruit 133 students and/or instructors per HEI
- *Duration*: ~20-30 minutes

## Preparation phase

- Invite participants through the following URL:
  - [https://trustid-project.eu/participate\\_upat.php](https://trustid-project.eu/participate_upat.php)
  - [https://trustid-project.eu/participate\\_uc.php](https://trustid-project.eu/participate_uc.php)
  - [http://trustid-project.eu/participate\\_ucy.php](http://trustid-project.eu/participate_ucy.php)
- Ask participants to subscribe to the PoC2 user evaluation study
  - Read information about the method of study, planned dates, etc.
  - Provide email so that we can communicate during the PoC2 study period

## Evaluation Phase

- **Step 1:** Participants download and install the implemented applications (Windows or MacOS)
- **Step 2:** Instructors enroll participants in the user study and they receive their login credentials in their email
- **Step 3:** Evaluate specific threat scenarios and functionalities
  - *Type of examination:* Digital oral, Digital written
  - *Impersonation threats*
    - Perform the student verification step based on *face-based* and *voice-based* identification
    - Continuous student identification based on *face* and *voice* data
  - *Collaboration/communication threats*
    - Monitoring the students' computing device's running applications and processes
  - *Other functionalities:*
    - Management of biometric models (Enroll/Update/Delete)
    - Integration of the new version of face-based identification which uses GRPC
    - Management of Examinations and LMS integration
      - Moodle integration - fetch students' information and automatically enroll to TRUSTID
      - Instructors upload .csv with students' information exported from other LMS
      - Add/Update examination to the TRUSTID system
- **Step 4:** Conduct semi-structured interviews and focus groups to receive feedback from the participants about their experience with the TRUSTID solution

# Study Registration

Co-funded by the  
Erasmus+ Programme  
of the European Union



The screenshot shows the TRUSTID website's 'Participation in a User Study in the frame of the TRUSTID Project' page. The page features a navigation menu at the top with links for 'WELCOME', 'ABOUT TRUSTID', 'CONSORTIUM', 'VIDEOS', 'INTELLECTUAL OUTPUTS', 'NEWS', and 'PUBLICATIONS'. The main content area is titled 'Participation in a User Study in the frame of the TRUSTID Project' and includes a 'DESCRIPTION' section. The description explains the project's goal to evaluate the Second Proof of Concept of TRUSTID, a system for intelligent and continuous online student identity management. It details the user survey process, which will be conducted via Zoom, and provides instructions for participants, including the need for a computer and webcam. A 'LATEST NEWS' sidebar on the right lists recent events such as a biweekly meeting, a dissemination workshop, and an invited talk at an APPS workshop.

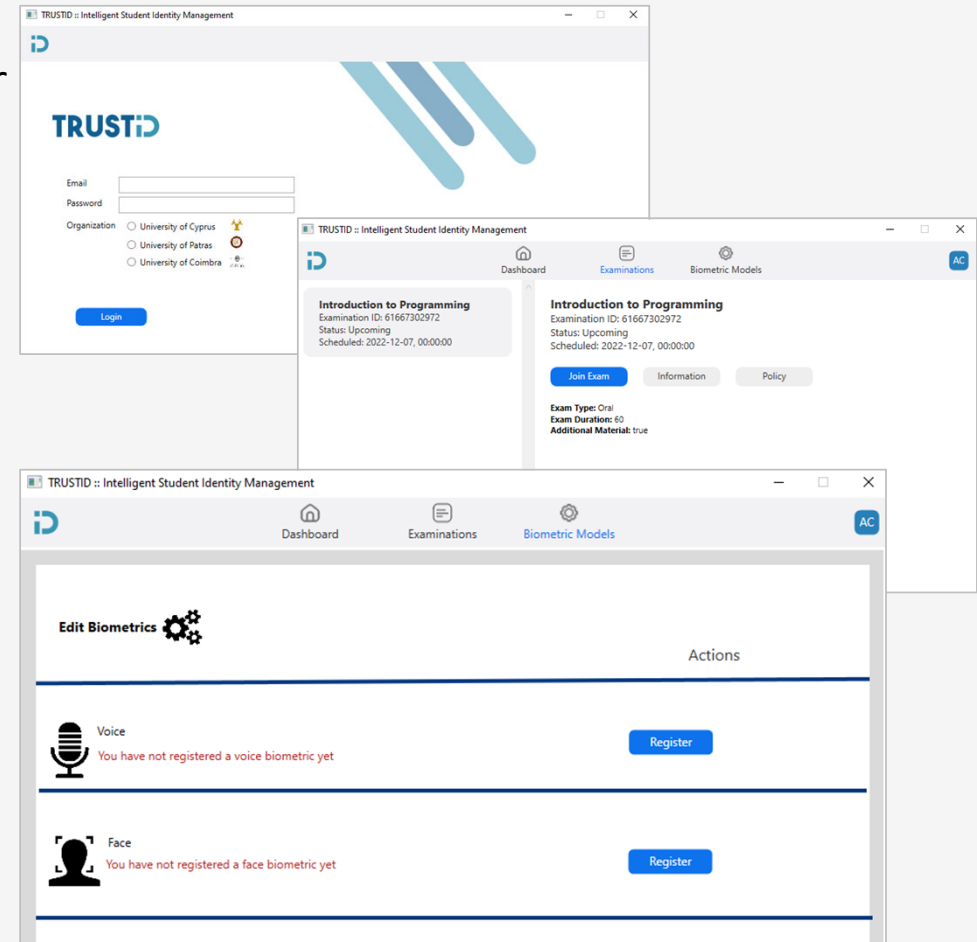
The screenshot shows the TRUSTID website's subscription form for the University of Coimbra, Institute of Systems and Robotics. The form is titled 'SUBSCRIBE ON BEHALF OF THE UNIVERSITY OF COIMBRA, INSTITUTE OF SYSTEMS AND ROBOTICS' and includes fields for 'FULL NAME', 'EMAIL', and 'OPERATING SYSTEM'. A 'SUBSCRIBE' button is located below the form. To the right of the form, there is a 'TRUSTID has a new logo' announcement dated December 22, 2021, and a 'Paper Acceptance' announcement dated November 20, 2021. Below the form, there is a section titled 'RESEARCH ETHICS AND PRIVACY OF PERSONAL DATA' which provides detailed information about data handling, confidentiality, and the user's right to leave the study at any time.

# Scenario 1 – Student Biometrics Enrollment

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Once the students log in to the system with their credentials, they will select their examination through the TRUSTID dashboard
- Students will be asked to enroll their biometrics (e.g., face, voice) through the biometrics management screen

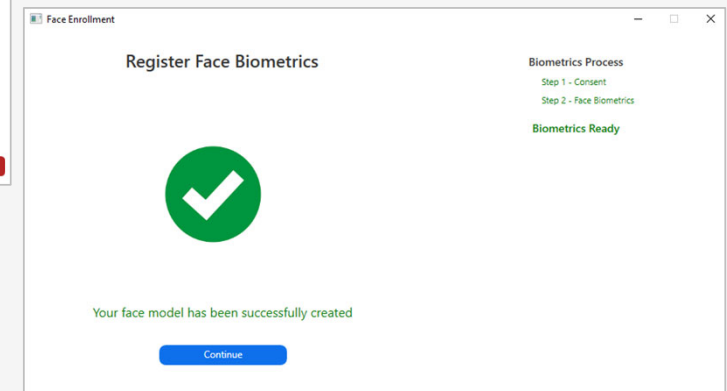
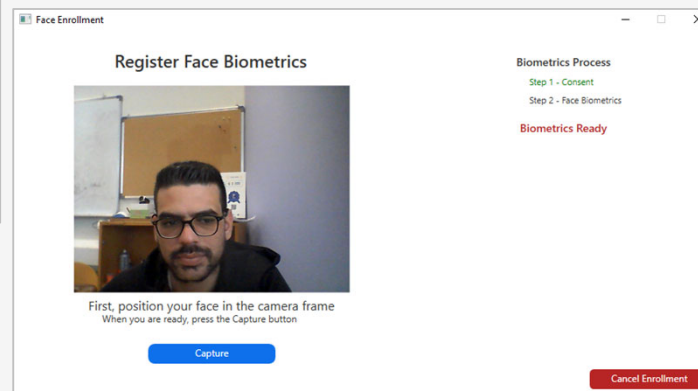
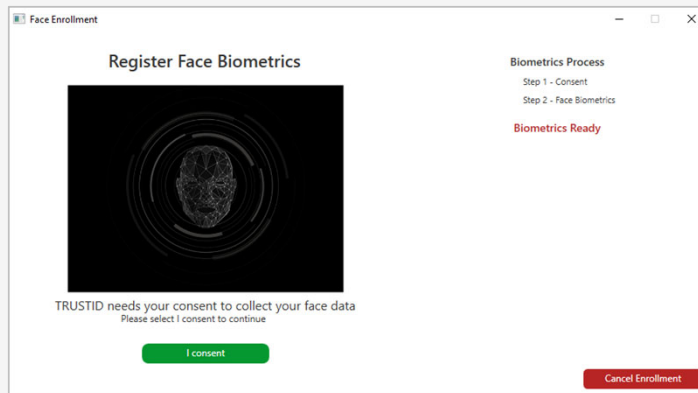


# Scenario 1 – Student Biometrics Enrollment (Face)

Co-funded by the  
Erasmus+ Programme  
of the European Union

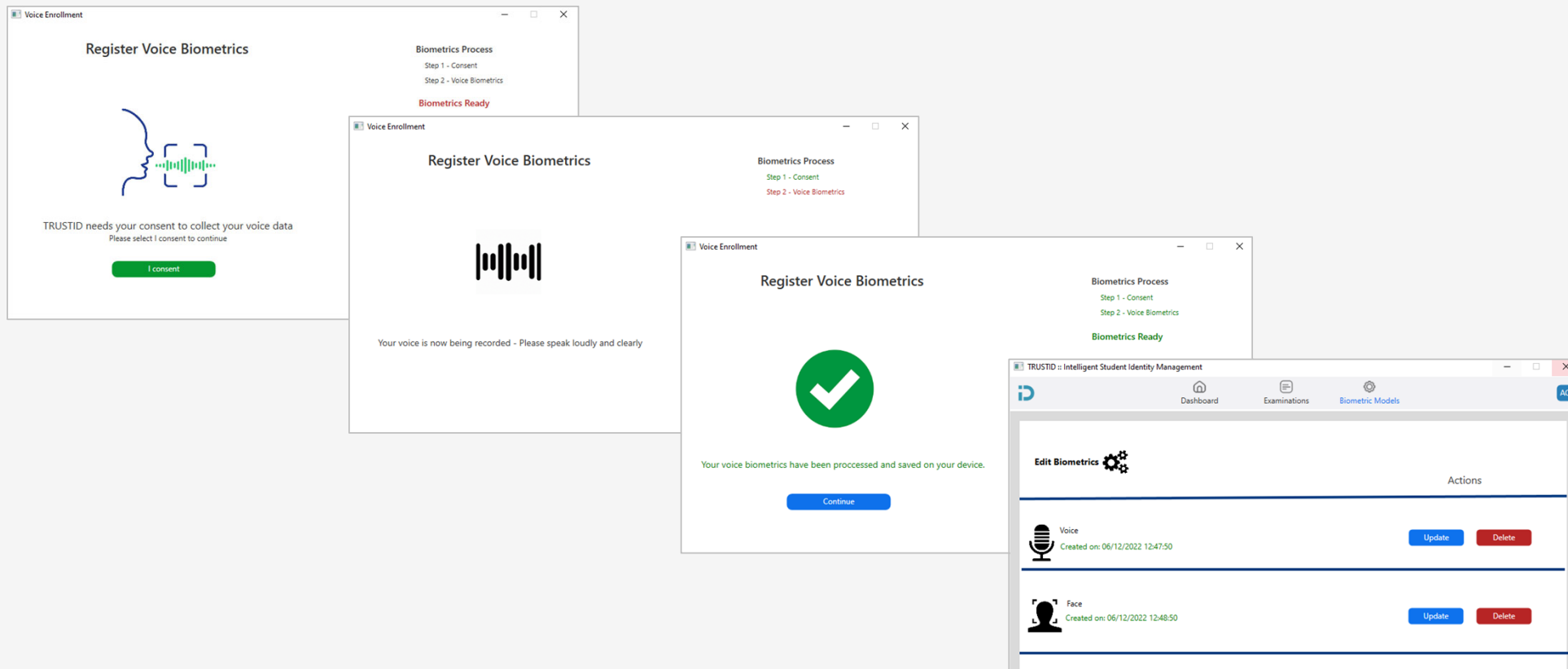


- The TRUSTID app captures student's face data and generates the face model



# Scenario 1 – Student Biometrics Enrollment (Voice)

- The TRUSTID app captures student's voice data and generates the voice model



The image displays a sequence of four screenshots illustrating the voice biometric enrollment process in the TRUSTID app:

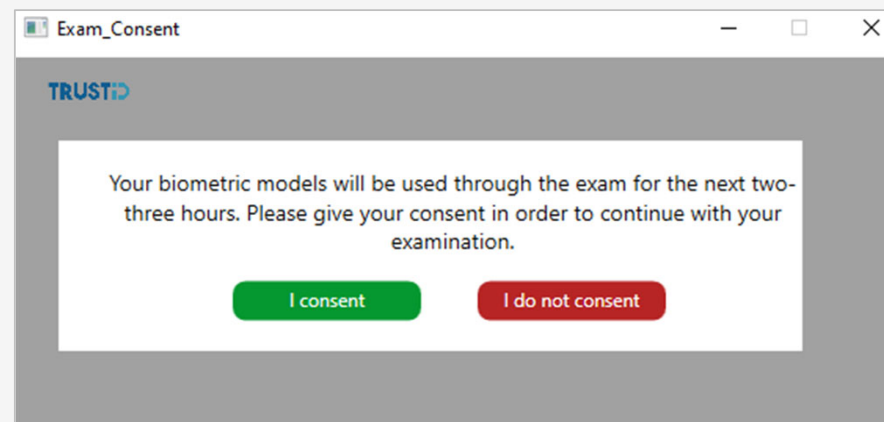
- Consent Screen:** Titled "Register Voice Biometrics", it prompts the user for consent. The text reads: "TRUSTID needs your consent to collect your voice data. Please select I consent to continue." A green "I consent" button is visible.
- Recording Screen:** Titled "Register Voice Biometrics", it indicates that the user's voice is being recorded. The text reads: "Your voice is now being recorded - Please speak loudly and clearly." A microphone icon is shown.
- Confirmation Screen:** Titled "Register Voice Biometrics", it confirms that the voice biometrics have been processed and saved. A large green checkmark is displayed, and the text reads: "Your voice biometrics have been processed and saved on your device." A blue "Continue" button is present.
- Management Dashboard:** Titled "TRUSTID :: Intelligent Student Identity Management", it shows a list of biometric models. The "Voice" model is highlighted, showing it was created on 06/12/2022 at 12:47:50. There are "Update" and "Delete" buttons for each model.

## Scenario 2 – Student Identity Verification

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Before initiating the examination, the student will provide their consent to use their biometric models, and they will then go through the identity verification step in which they will be identified through the implemented face- and voice-based identification mechanisms



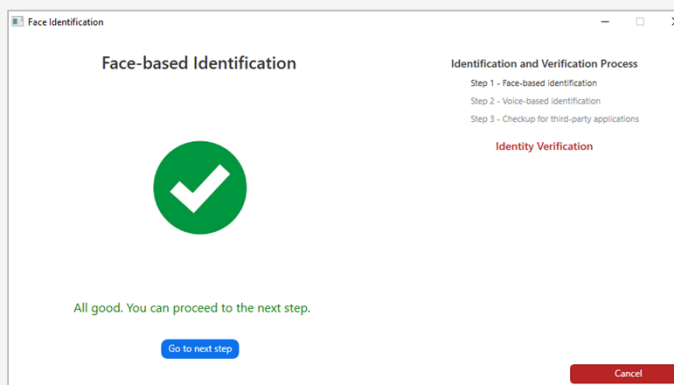
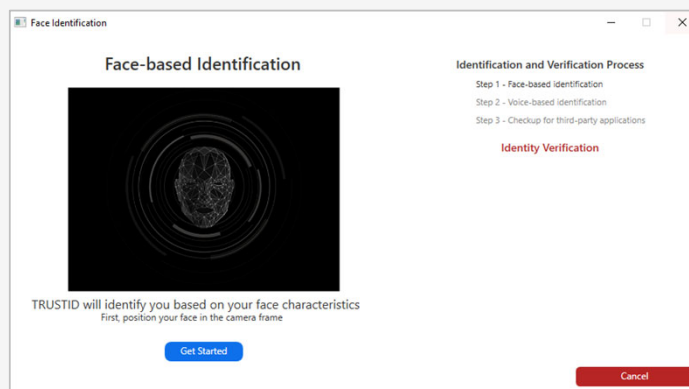


# Scenario 2 – Student Identity Verification (Face)

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Students will be requested to misuse the system, e.g., use impersonation, in which another person will sit in front of the camera to verify their identity

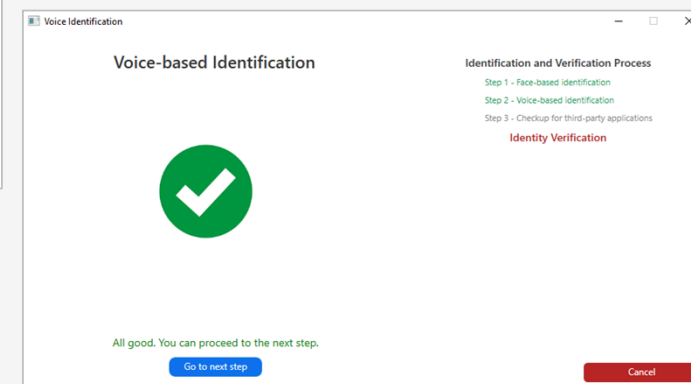
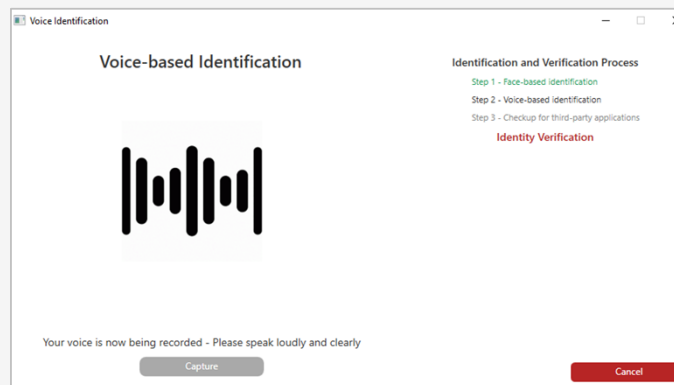
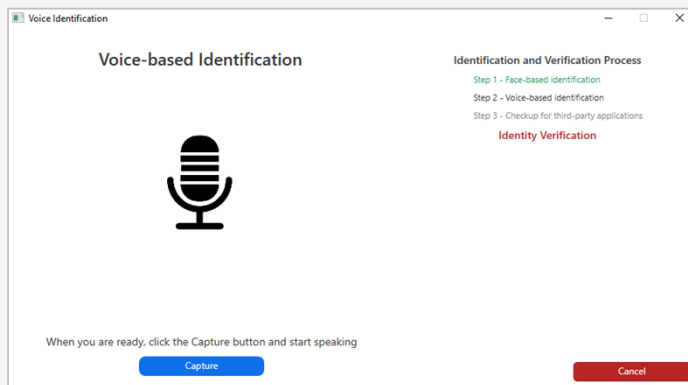


# Scenario 2 – Student Identity Verification (Voice)

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Students will be requested to misuse the system, e.g., use impersonation, in which another person will speak to the microphone to verify their identity

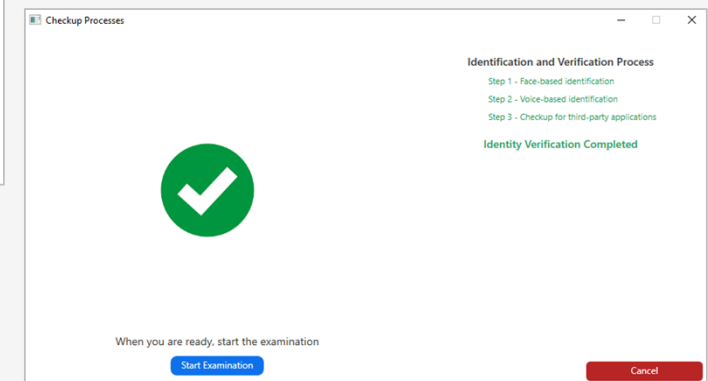
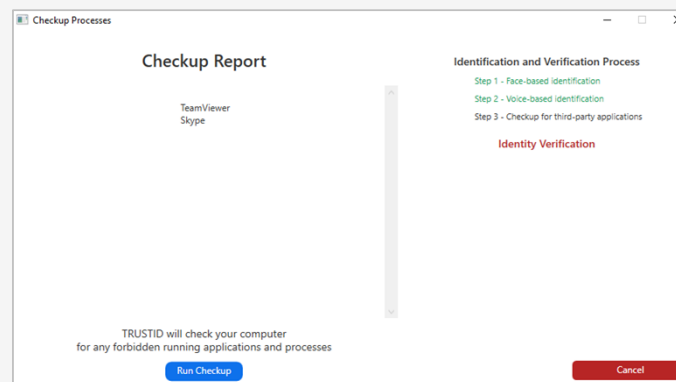
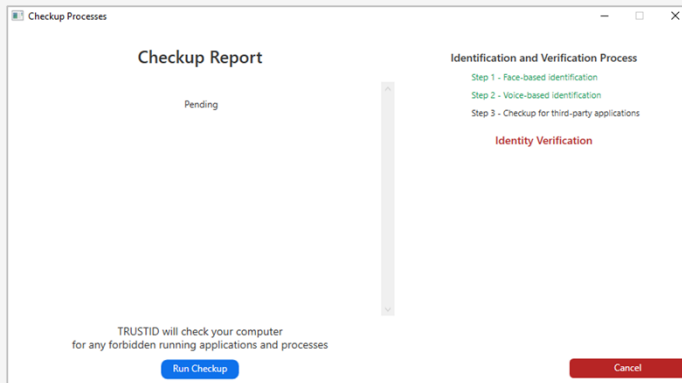


# Scenario 2 – Student Identity Verification (Checkup Forbidden Applications)

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Students will be requested to misuse the system, e.g., use communication/collaboration tools prior to joining the examination

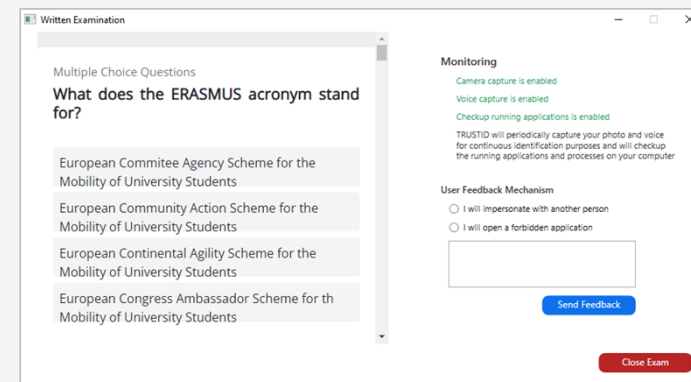


# Scenario 3 – Continuous Student Identification

Co-funded by the  
Erasmus+ Programme  
of the European Union



- The system will continuously identify the students through the continuous face- and voice-based identification mechanism
  - Students will be requested to misuse the system, e.g., use impersonation, in which another person will sit in front of the camera or will speak to the microphone to verify their identity

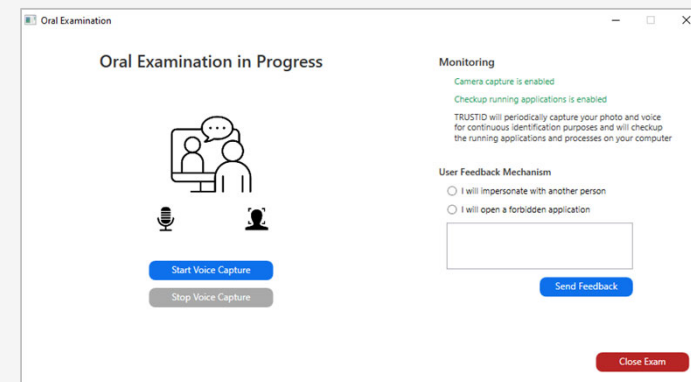


# Scenario 4 – Monitoring the Student’s Computing Device

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Monitoring the students’ computing device’s running applications and processes
  - Students will be asked to misuse the system, e.g., by asking them to open communication/collaboration tools during the examination session



# Scenario 5 – Examination Management for Instructors

Co-funded by the  
Erasmus+ Programme  
of the European Union



## - Add/Update examination

The image displays four overlapping screenshots of the TRUSTID Intelligent Student Identity Management system interface:

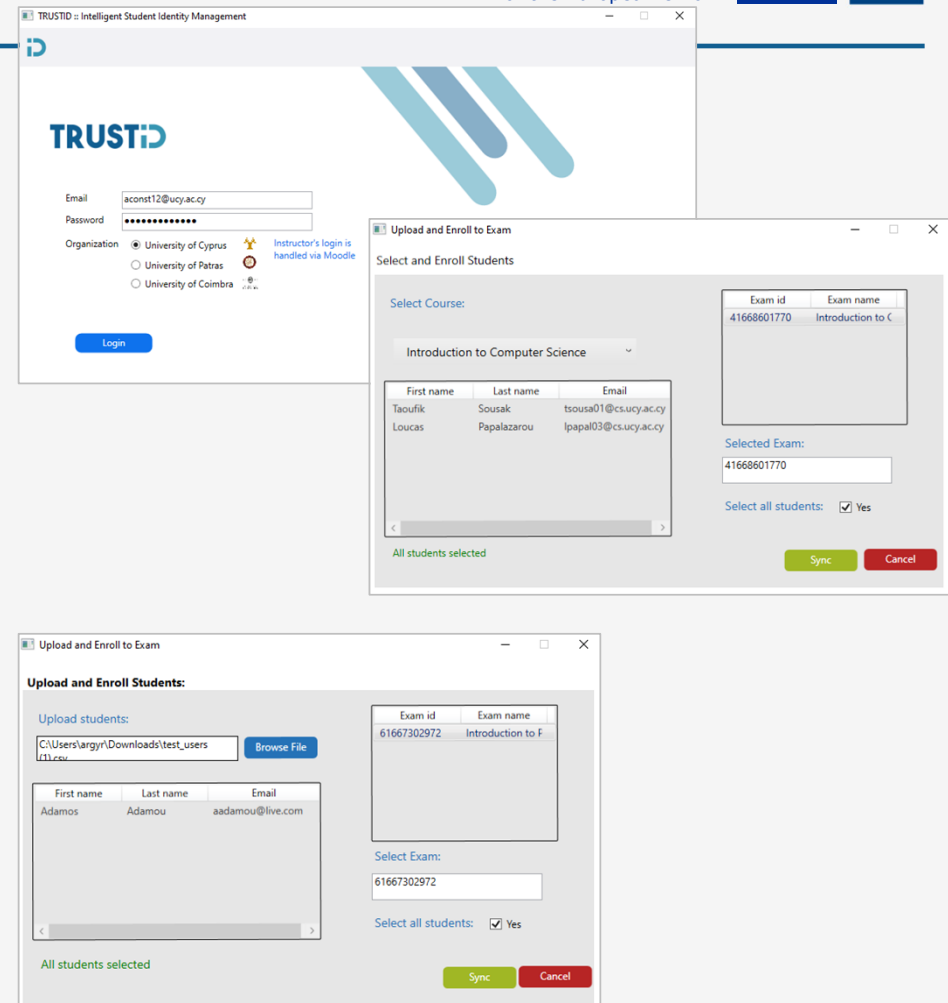
- Top Left:** Overview page for an examination titled "Introduction to Programming". It shows the Examination ID (61667302972), Status (Upcoming), and Scheduled date (2022-12-07T00:00:00). A "Start Exam" button is visible.
- Top Right:** "Management" page with three main actions: "Add a new exam" (Add Exam button), "Edit existing exams" (Edit Exams button), and "Enroll students to exam" (Enroll button).
- Bottom Left:** "Add Exam" form with fields for: Additional Material (checkbox Yes/No), Exam Duration (text input), Exam Type (dropdown menu set to "Oral"), Name (text input), Privacy Policy (text input), and Scheduled date (calendar picker). "Add" and "Cancel" buttons are at the bottom.
- Bottom Right:** "Update Exam" form for "Introduction to Program" with fields for: Additional Material (checkbox Yes/No, checked), Exam Duration (text input with value 60), Exam Type (dropdown menu set to "Oral"), Privacy Policy (text input with value "The privacy policy of the exam"), and Scheduled date (calendar picker with value 07/12/2022). "Update" and "Cancel" buttons are at the bottom.

# Scenario 6 – LMS Integration

Co-funded by the  
Erasmus+ Programme  
of the European Union



- Moodle integration
  - Fetch students' information and automatically enroll to TRUSTID
- Instructors upload .csv with students' information exported from other LMS



# Resilience to Impersonation Attacks

Co-funded by the  
Erasmus+ Programme  
of the European Union



## Summary of the sample and the collected data

Mock Examination Type	# of Participants	# of Face Images	Audio Samples Length (in minutes)
<i>Online Written</i>	65	1804	75.68
<i>Online Oral</i>	68	1530	123.47
<b>Totals</b>	133	3334	199.15

## Summary of the sample and the collected data for impersonation attacks

Mock Examination Type	# of Participants	# of Face Images	Audio Samples Length (in minutes)
<i>Online Written</i>	24	391	31.04
<i>Online Oral</i>	32	582	52.73
<b>Totals</b>	56	973	83.77



# Summary of the results for each identification case

Co-funded by the  
Erasmus+ Programme  
of the European Union



Identification Case	Face Recognition (Success Rate)	Voice Recognition (Success Rate)
<i>Student identification in order to join examination</i>	100%	100%
<i>Continuous student identification prior to performing an impersonation attack</i>	94.80%	91.36%
<i>Continuous student identification while performing an impersonation attack</i>	76.57%	78.53%

# Questionnaire Results

Co-funded by the  
Erasmus+ Programme  
of the European Union



Question	Disagree	Moderate	Agree
Overall, how simple and clean is the TRUSTID software's user interface?	3	10	89
Overall, how intuitive to navigate is the TRUSTID software's user interface?	2	11	89
Overall, what's your opinion on the way features and information in the TRUSTID software are laid out?	5	10	87
Overall, how secure do you find the face identification process?	9	22	71
Overall, how secure do you find the voice identification process?	12	23	67
Overall, do you like the idea to be identified with face-based biometric identification during an online examination?	21	20	61
Overall, do you like the idea to be identified with voice-based biometric identification during an online examination?	26	24	52

# Key Findings

## *What worked well in PoC2:*

- The System Usability Score was calculated to be 78, which is a high score (Any score above 68 would be considered above average[1]).
- Face enrollment.
- Face identification in both the registration and continuous monitoring phases.
- Continuous monitoring of running processes and detection of forbidden communication/collaboration tools.

## *Improvements for PoC3:*

- Voice enrollment and voice identification issues in some cases. Relevant quotes:

*“The voice registration wasn't successful the first few times” ~ P6*

*“The voice registration did not work, I had to change my default microphone input in windows for it to work” ~ P7*

*“Voice recognition didn't work at first, but worked once I put headphones on, even though the microphone used was always the same, an independent one from the headphones” ~ P14*

[1] <https://www.usability.gov/>

Co-funded by the  
Erasmus+ Programme  
of the European Union



TrustID 

# Thank you!

Dr. Argyris Constantinides, University of Cyprus



University  
of Cyprus



**cognitiveux**