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TRUSTID Multiplier Event in Germany

Project Information and Technology Day – TRUSTID Info and Tech Day

16th and 17th of May 2023

Marios Belk, Cognitive UX GmbH

Agenda

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Project Information and Technology Day – TRUSTID Info and Tech Day
Gathering and Welcome Speech by the Host – *Dr. Mario Belk*
Introduction and Overview of the TRUSTID Project – *Dr. Mario Belk*
Ensuring Academic Integrity and Trust in Online Learning Environments: Main Outcomes from a Longitudinal Study on the Analysis, Implementation and Evaluation of an AI-centered Proctoring System in Higher Education Institutions – *Dr. Mario Belk*
Coffee Break and Networking
Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces – *Mr. Michail-Panagiotis Bofos and Dr. Argyris Constantinides* - TRUSTID Live System Demonstration - Integrating and Using the TRUSTID Open-Source Technology - Hands-on Interaction with the Open-source TRUSTID Technology
Coffee Break and Networking
Conclusions, Discussions and Networking

TRUSTID Overview

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- *TRUSTID: "Intelligent and Continuous Online Student Identity Management for Improving Security and Trust in European Higher Education Institutions"*

- Part of the actions of Erasmus+ 2020 and in particular the Call *"Strategic Partnerships in Response to the COVID-19 Situation: Partnerships for Digital Education Readiness in the field of Higher Education (KA226)"*

- *Duration:* June 2021 - May 2023 (24 Months)

- Currently pursuing Month 24 of the project

Project Partners

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- Department of Electrical and Computer Engineering, University of Patras, Patras, Greece *(Project Coordinator)*
- Department of Computer Science, University of Cyprus, Nicosia, Cyprus *(Project Partner)*
- Institute of Systems and Robotics, University of Coimbra, Coimbra, Portugal *(Project Partner)*
- Cognitive UX GmbH, Heidelberg, Germany *(Project Partner)*

Covid-19 outbreak: Problem and Challenges in HEI's

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- Before the Covid-19 outbreak many HEI's followed a blended learning educational model

Ambiguities

Environment
Physical and Digital

Covid-19 outbreak: Problem and Challenges in HEI's

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- Challenges
  - Continuously and seamlessly identify students while preserving their privacy and without interrupting or interfering with the current learning activities of each HEI
  - Provide insights to instructors in order to take informed decisions for their classes and attendees
  - Provide alternative integration capabilities and modes of TRUSTID in order to better adapt to specific requirements of each HEI

TRUSTID Vision

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Design, develop and evaluate a multi-tier continuous student identification framework, bootstrapped to HEIs' needs, that will consist of state-of-the-art intelligent image, voice and interaction data processing while preserving their privacy

Core Objectives

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- Literature review on current practices and procedures related to student identity management of EU HEIs and triangulate findings with stakeholders' studies at the participating HEIs

- Design and develop an integrated framework for student identity management

- Validate the solution through a User-Centered Design (UCD) methodology; two formative studies are planned, during the software development process; and one summative study is planned, after the final release of the software

- Create a repository that will support knowledge building

- Dissemination and exploitation activities – *research papers, workshops, seminars, LTTAs, etc.*

Intellectual Outputs

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- **Intellectual Output 1:** Analysis & validation of the TRUSTID framework for HEIs' continuous student identity management *(Conceptual)*

- **Intellectual Output 2:** Implementation of an open-source software toolkit *(Operational)*

- **Intellectual Output 3:** Evaluation and validation reports in the context of three case-studies at different HEIs *(Lessons Learned and Guidelines)*

- **Intellectual Output 4:** Knowledge building online community and repository *(Sustainability)*

Key Achievements and Milestones reached

Intellectual Output 1 – Tasks and Achievements

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IO1 - Needs Analysis and Design of the Theoretical Framework for Continuous Student Identity Management

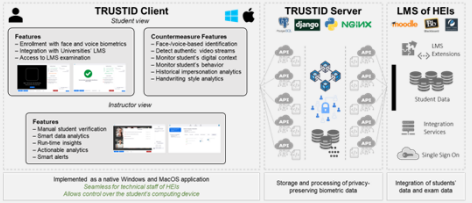
Output: Publications, Other, Dataset

- Task 1.1: Needs Analysis on Identity Management in HEIs
- Task 1.2: Needs Verification at HEIs
- Task 1.3: Specification of the Framework

Achievements and Outputs

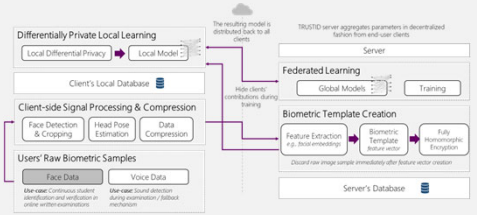
Specifications of the TRUSTID framework

- Refined the framework
- Specifications for the face, voice and interaction identification mechanism
- Specifications for LMS integrations of TRUSTID at UPAT, UCY, UC sites



Privacy-preserving architecture for continuous student identity management

- Designed the privacy-preserving architecture
- Defined the privacy-preserving smartphone wallet
- Defined the flow between client and server applications of TRUSTID towards achieving privacy-preservation of users' biometric data



Intellectual Output 2 - Tasks and Achievements

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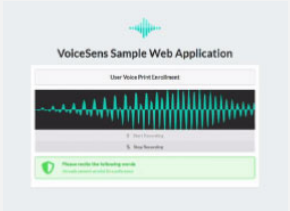
IO2 - Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces

Output: Software, Services, Publications

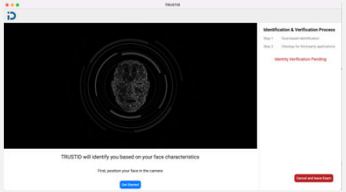
- Task 2.1: Architecture Design
- Task 2.2: Privacy-preserving Biometrics
- Task 2.3: Development of Voice-, Image- and Interaction-based Algorithms
- Task 2.4: Integration and Verification Testing

Achievements and Outputs

Major **improvement of the face-based identification** mechanism enrollment and continuous identification

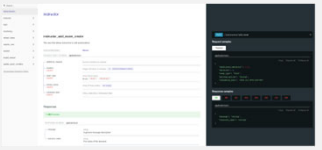


Development of the **voice-based and interaction-based identification** mechanisms



Implemented a new **architecture for privacy-preservation**

Prototype designs and implementations



Development and integration of new features in the **native Windows and MacOS applications**

Mechanisms for **LMS integration**

Application Programming Interface, end-points for service integration

Intellectual Output 3 - Tasks and Achievements

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IO3 - Evaluation Reports regarding Efficiency, Effectiveness and User Acceptance of TRUSTID in Three Case Studies at Higher Education Institutions across Europe

Output: Dataset, Publications

- Task 3.1: Design of Experimental Evaluation Methodology
- Task 3.2: Formative Evaluation Report
- Task 3.3: Summative Evaluation Report

Achievements and Outputs

Successfully completed the PoC2 study with 133 participants, which participated in the user evaluation study in which they interacted with various mechanisms of TRUSTID.

Planned and organized the **final summative evaluation study**

Running the final summative formative user study to test the final proof of concept and evaluate its usability and accuracy of implemented identification mechanisms (face, voice, interaction).

Intellectual Output 4 - Tasks and Achievements

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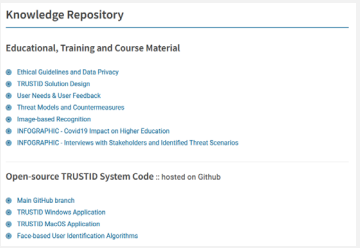
IO3 - Knowledge Repository containing Training Webinars, Guides of Best Practices, Integration Guidelines, Training Materials and Forum Discussions on how to Adopt and Deploy Continuous Student Identity Management Solutions in HEIs

Output: Internet, Broadcast, Event, Publications, Video

- Task 4.1: Training Webinars
- Task 4.2: Best Practice Guides
- Task 4.3: System Integration Guidelines (through an Application Programming Interface)

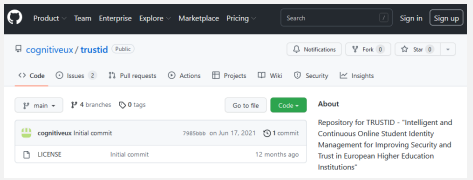
Achievements and Outputs

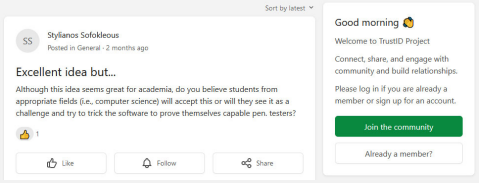
Deployment of Final Knowledge Repository
https://trustid-project.eu/kr.php



Deployment of Final TRUSTID Community Forum
https://trustid-project.eu/community.php

TRUSTID GitHub Open-source Code Repository
Available at: https://github.com/cognitiveux/trustid





Webinar
TRUSTID Webinar Events

- UPAT Event
- CUX Event
- ISR-UC Event
- UCY Event

Ensuring Academic Integrity and Trust in Online Learning Environments

Main Outcomes from a Longitudinal Study on the Analysis, Implementation and Evaluation of an AI-centered Proctoring System in Higher Education Institutions

Needs Analysis

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- *Aims*
  - Verify the needs analysis with the active involvement of the participating HEIs
  - Identify the current authentication and identity management practices and their drawbacks within the online/distance learning domain

- Conduct a series of semi-structured interviews with stakeholders with the university partners
  - *Sample:* 31 stakeholders participated from all partner HEIs

Three-phase methodology

- **Phase A:** Needs Analysis
- **Phase B:** Needs Verification Analysis
- **Phase C:** Countermeasures and Features

Stakeholder Group	Higher Education Institution 1	Higher Education Institution 2	Higher Education Institution 3
Students	2	3	3
Instructors	3	4	3
System Administrators	2	2	2
Decision Makers	2	1	1
Data Protection Experts	1	1	1
Total	**10**	**11**	**10**

Identification of Impersonation Threat Scenarios

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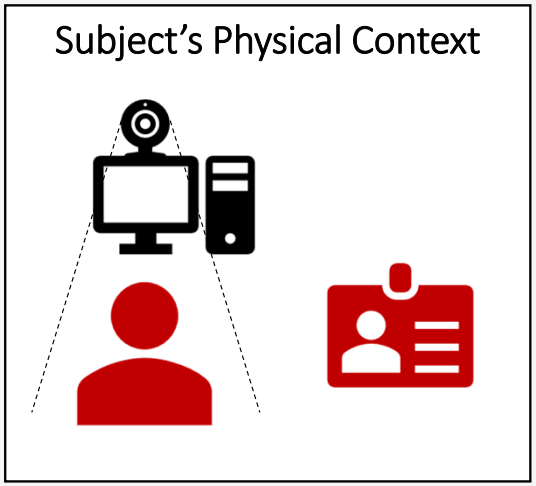
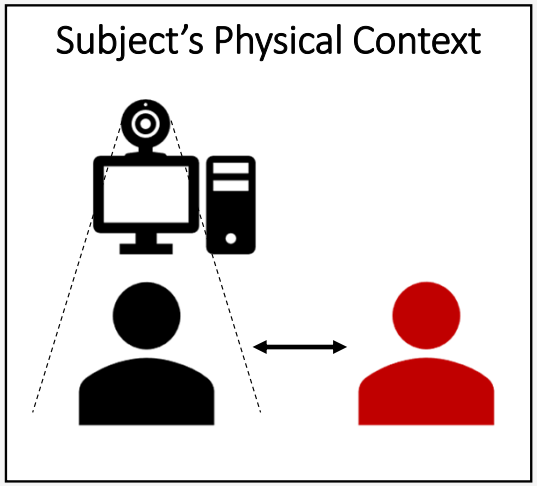
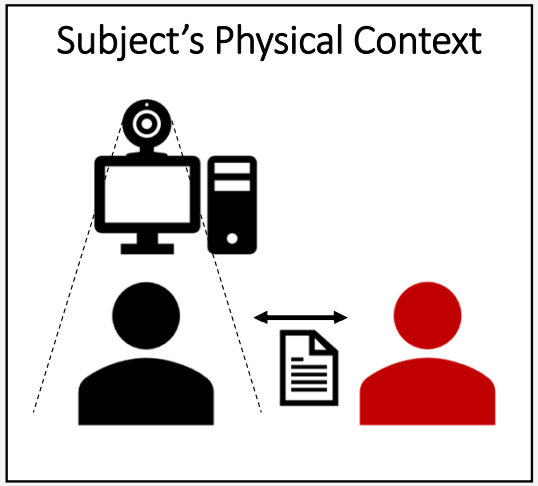


Subject fakes his/her identity proofs during enrolment



Subject switches seats with another person after enrolment



Exchange of hardcopy written messages

Identification of Communication, Collaboration and Resource Access Threat Scenarios

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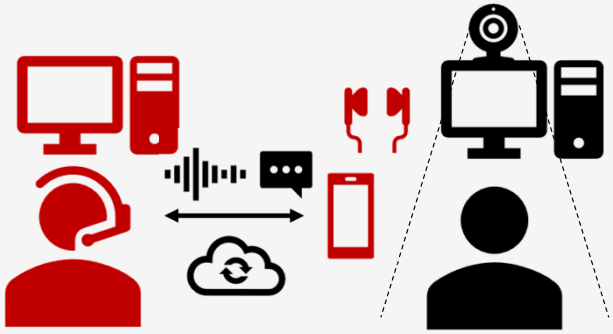
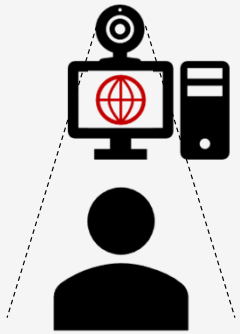
- Computer Mediated Scenarios



Remote communication/collaboration between a smartphone or another computer of the subject and another remote computer
B_1: *Communication through voice or chat*
B_2: *Collaboration through mobile application (e.g., remote desktop connection)*



Subject seeks for help from online resources, search engines, which are not allowed based on the examination policy

Identification of Communication, Collaboration and Resource Access Threat Scenarios

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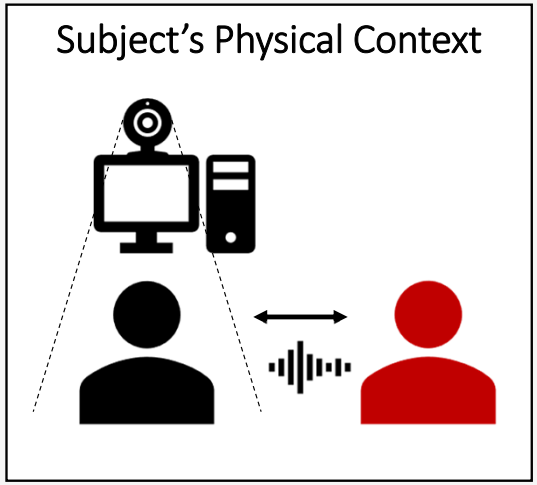
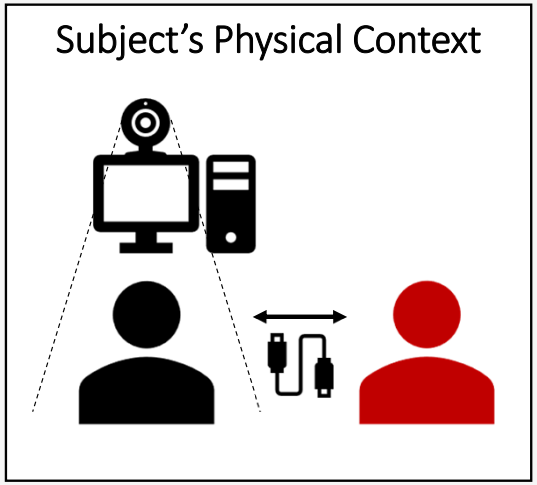
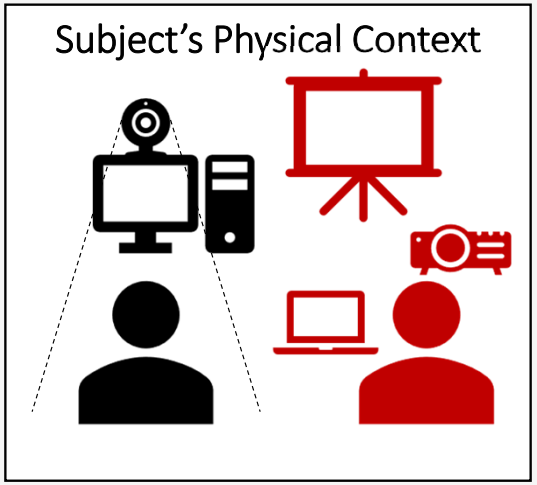
- In-situ Scenarios



Interaction with another person in the same room through voice



Another person that is in the same room as the subject is interacting with the examination using other devices of the subject's computer



Projection of answers on a whiteboard

Threat Model, Data Metrics and Countermeasures

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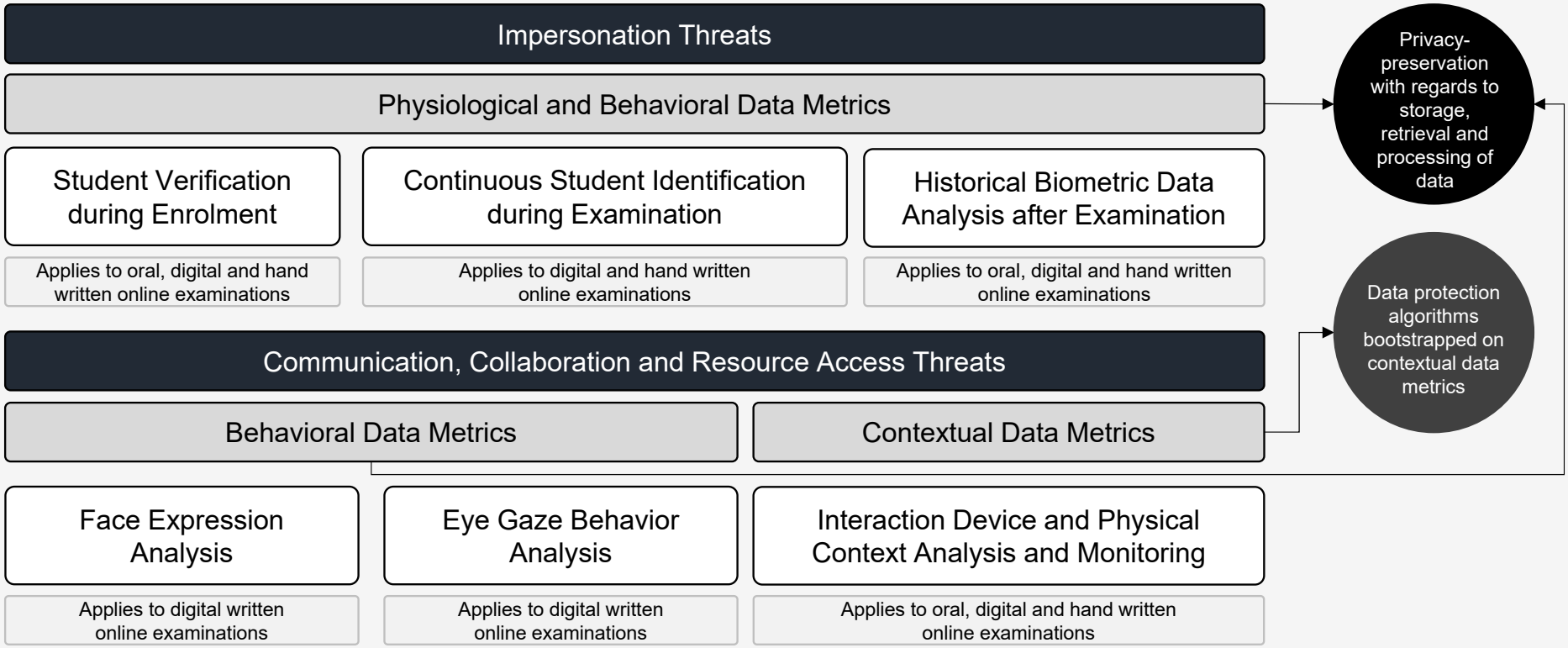

Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces

Intellectual Output 2 (IO2)

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- Design and Implementation of Open-source Privacy-preserving Toolkit and Application Programming Interfaces

- *Lead:* Cognitive UX GmbH
- *Participating Partners:*
  - University of Patras
  - University of Cyprus
  - University of Coimbra ISR

- *Output type:* Services / structures – E-learning platform
- *Media:* Software, Service, Publications

IO2 - Tasks and Task Leaders

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- Task 2.1: Architecture Design
  - *Lead:* Cognitive UX GmbH
  - *Participating:* University of Patras, University of Cyprus, University of Coimbra
- Task 2.2: Privacy-preserving Biometrics
  - *Lead:* University of Cyprus
  - *Participating:* University of Patras, University of Coimbra, Cognitive UX GmbH
- Task 2.3: Development of Voice-, Image- and Interaction-based Algorithms
  - *Lead:* Cognitive UX GmbH
  - *Participating:* University of Patras, University of Cyprus, University of Coimbra
- Task 2.4: Integration and Verification Testing
  - *Lead:* Cognitive UX GmbH
  - *Participating:* University of Patras, University of Cyprus, University of Coimbra

TRUSTID High-level Framework

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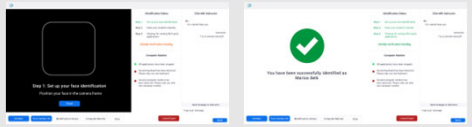
TRUSTID Client

Student view

Features
– Enrollment with face and voice biometrics
– Integration with Universities' LMS
– Access to LMS examination



Countermeasure Features
– Face-/voice-based identification
– Detect authentic video streams
– Monitor student's digital context
– Monitor student's behavior
– Historical impersonation analytics
– Handwriting style analytics

Instructor view

Features
– Manual student verification
– Smart data analytics
– Run-time insights
– Actionable analytics
– Smart alerts

Implemented as a native Windows and MacOS application
Seamless for technical staff of HEIs
Allows control over the student's computing device

TRUSTID Server

PostgreSQL django NGINX

API

Storage and processing of privacy-preserving biometric data

LMS of HEIs

moodle Blackboard open eclass

LMS Extensions

Student Data

Integration Services

Single Sign On

Integration of students' data and exam data

Student Interaction

Client Application

Windows and MacOS

Integrated Login

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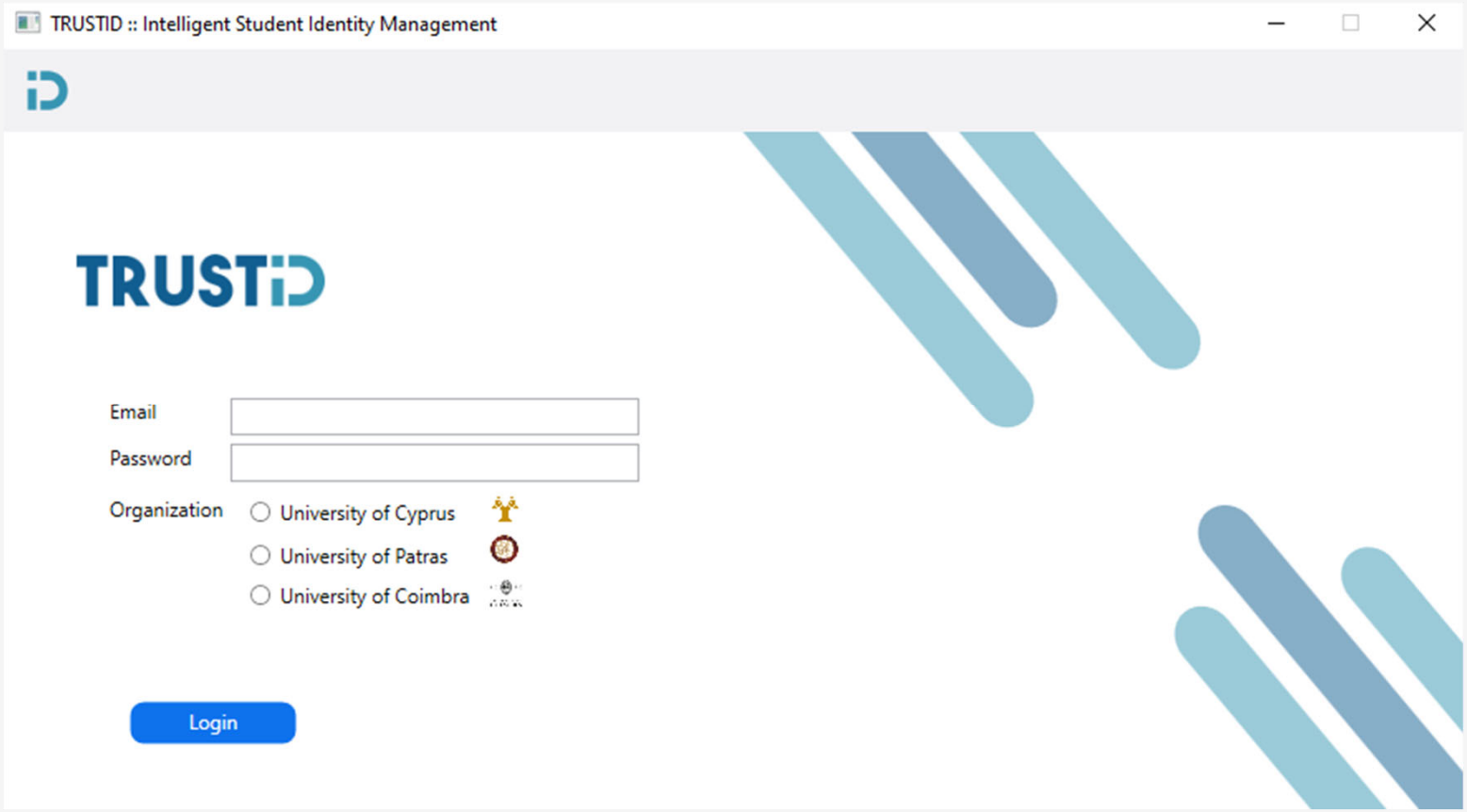

Register Face Biometrics

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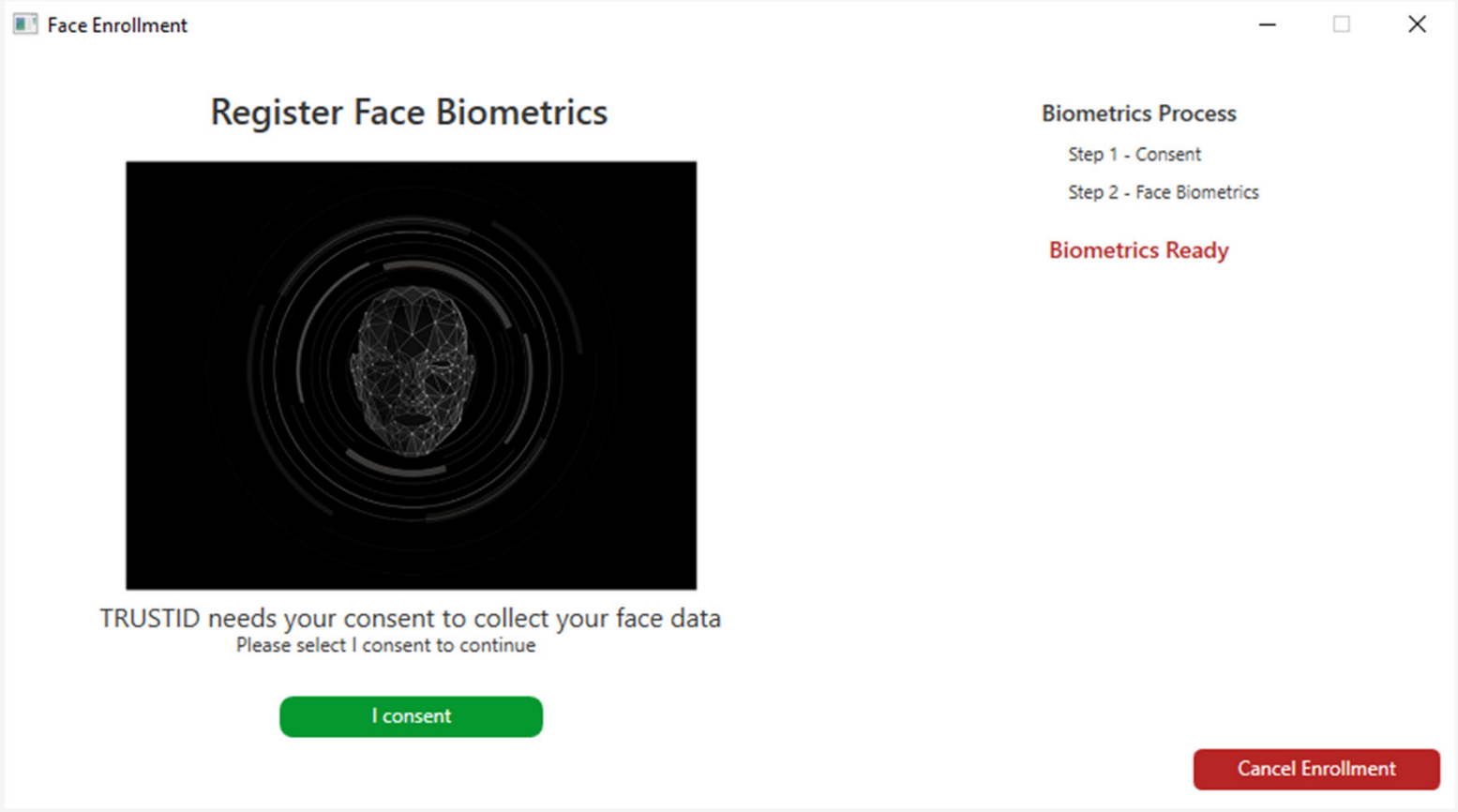

Register Voice Biometrics

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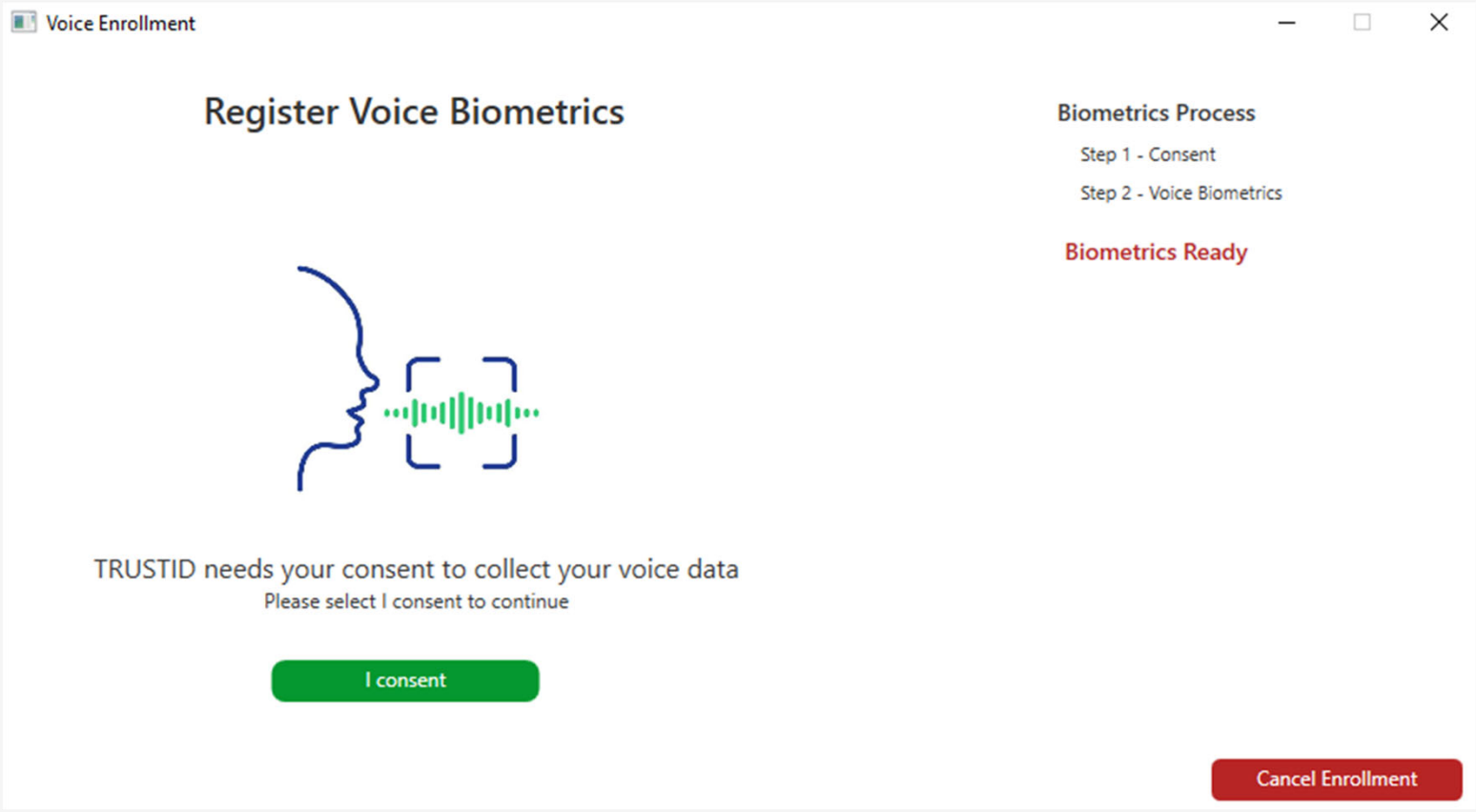

Control and Manage Biometrics

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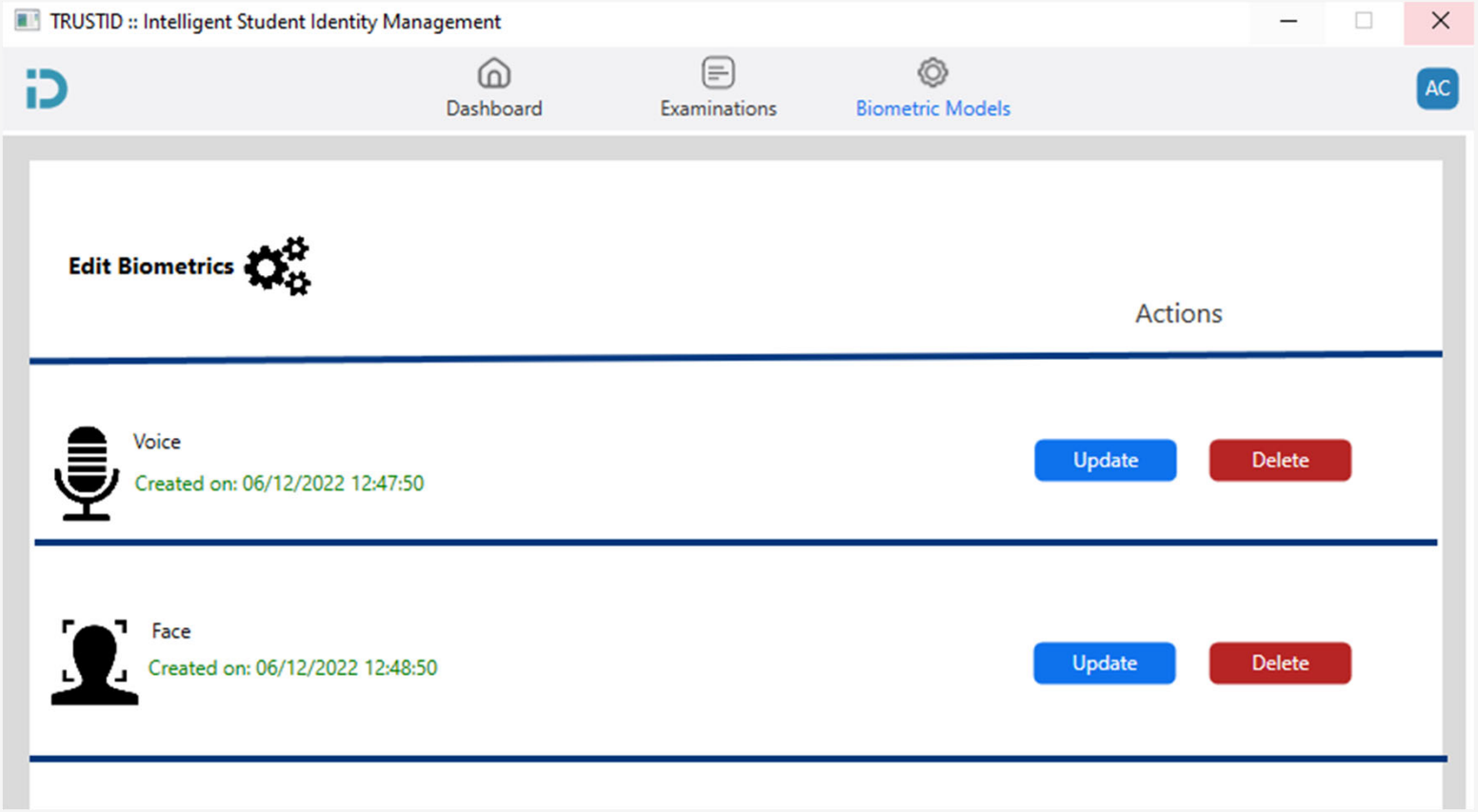

Continuous Face Identification

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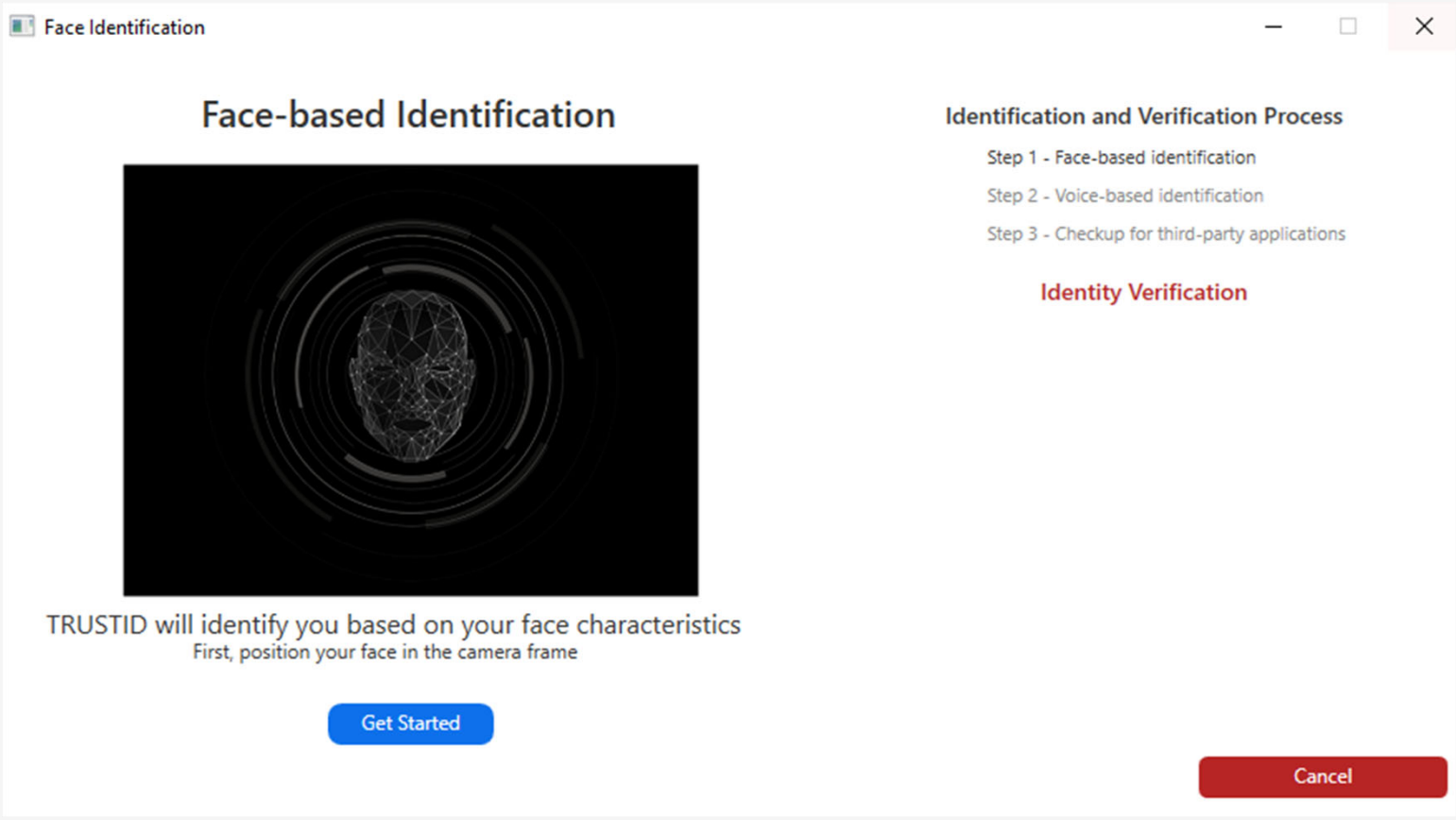

Continuous Voice Identification

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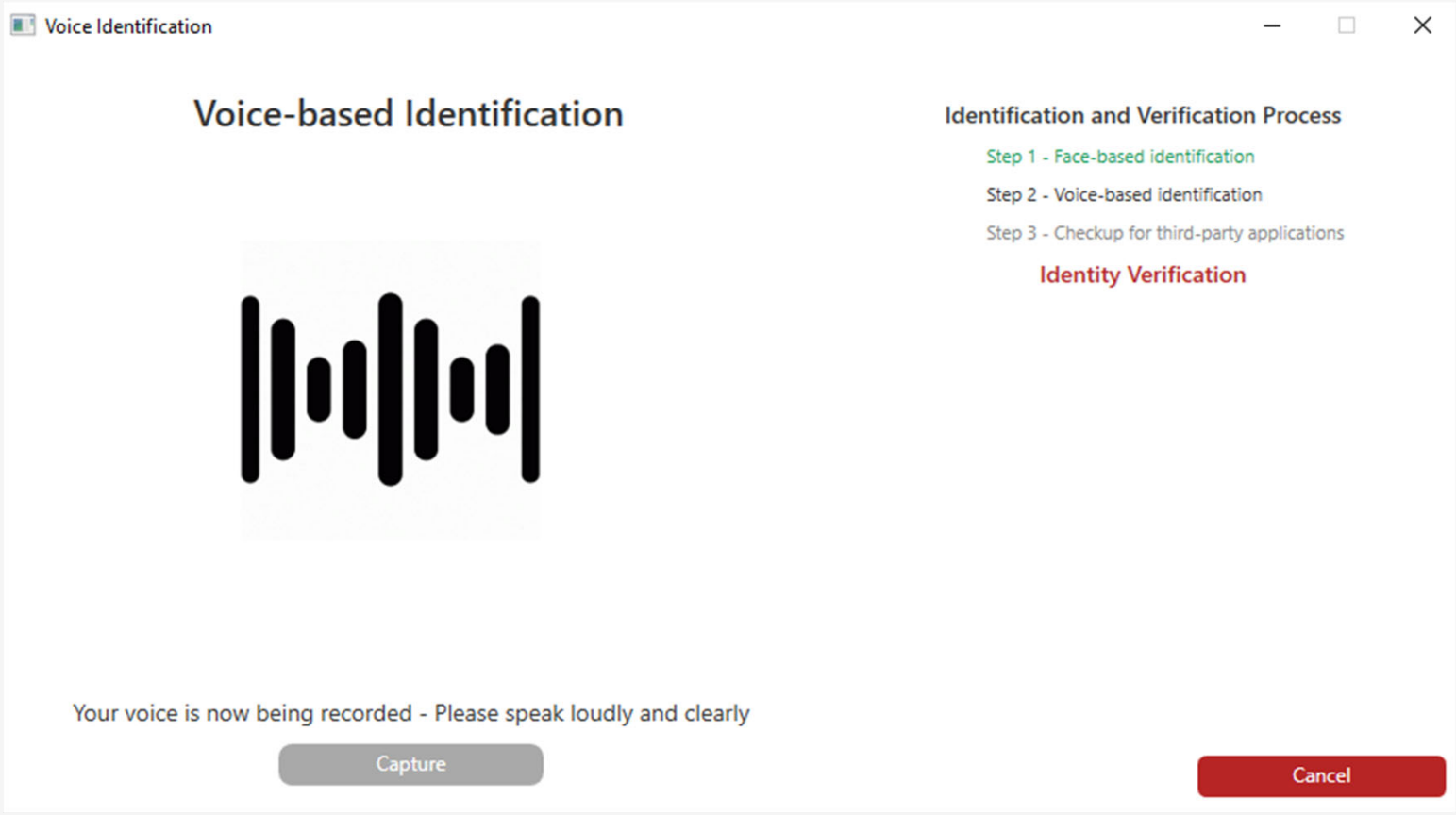

Digital Written Examination Scenario

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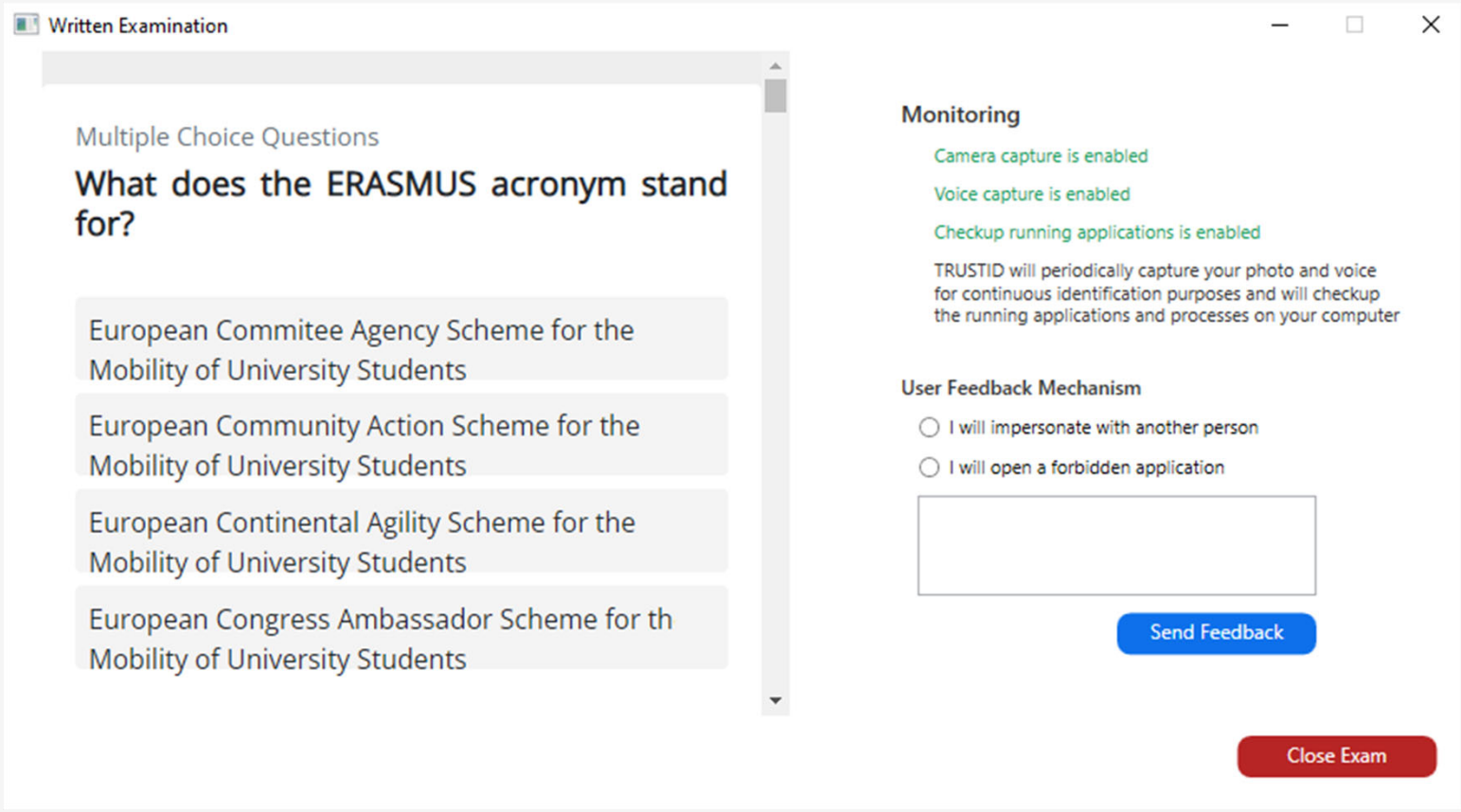

Oral Examination Scenario

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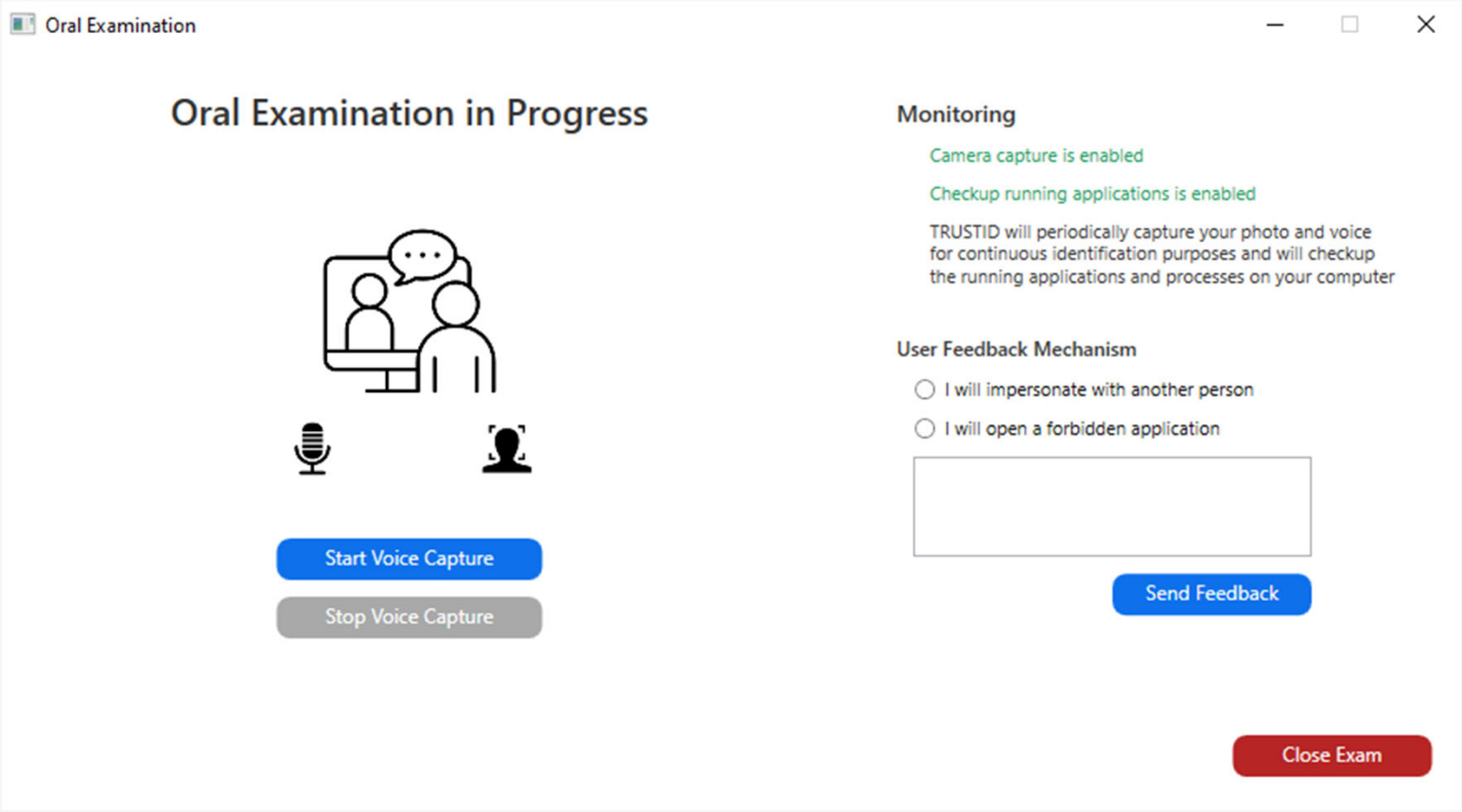

Examination Management Dashboard

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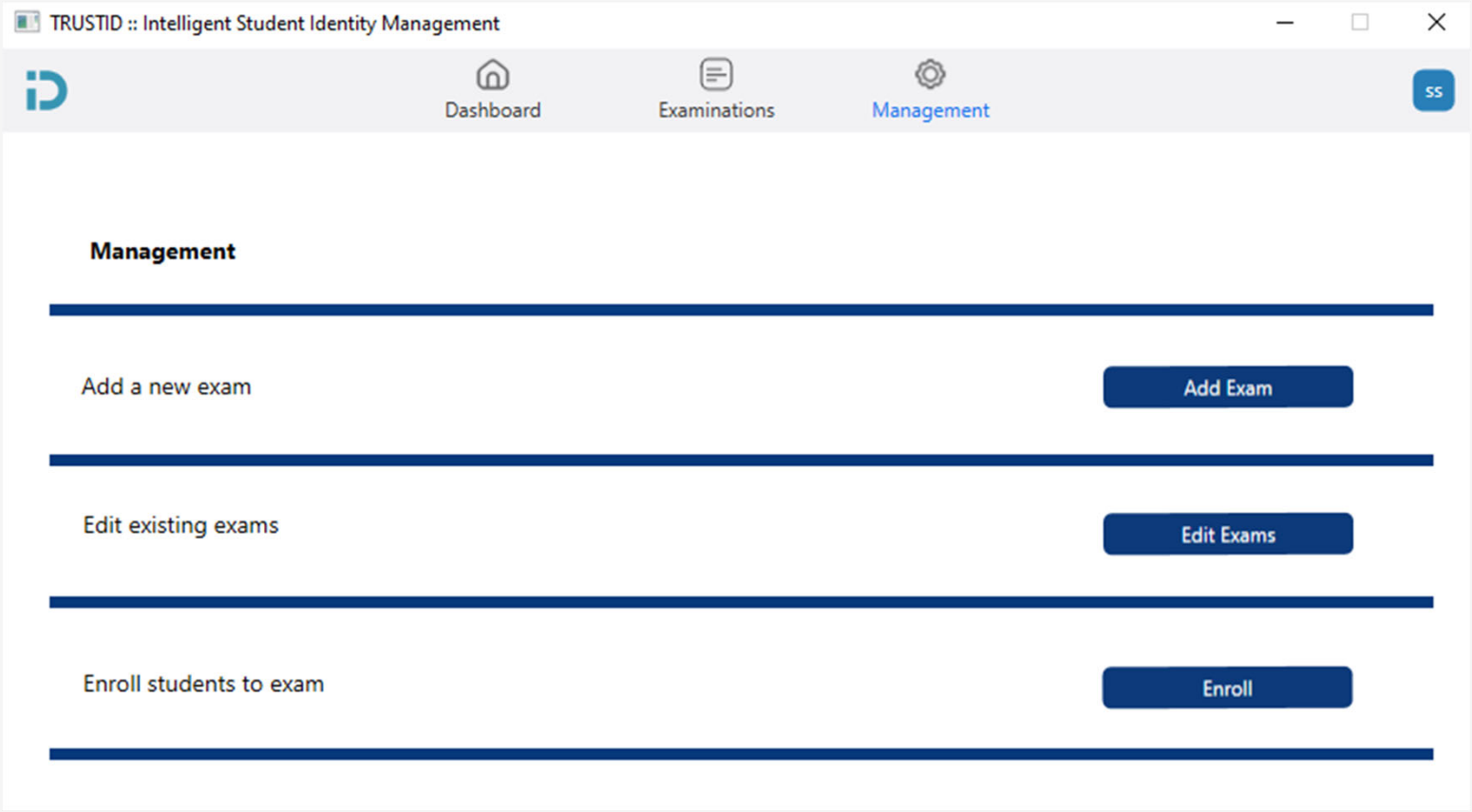

Examination Management

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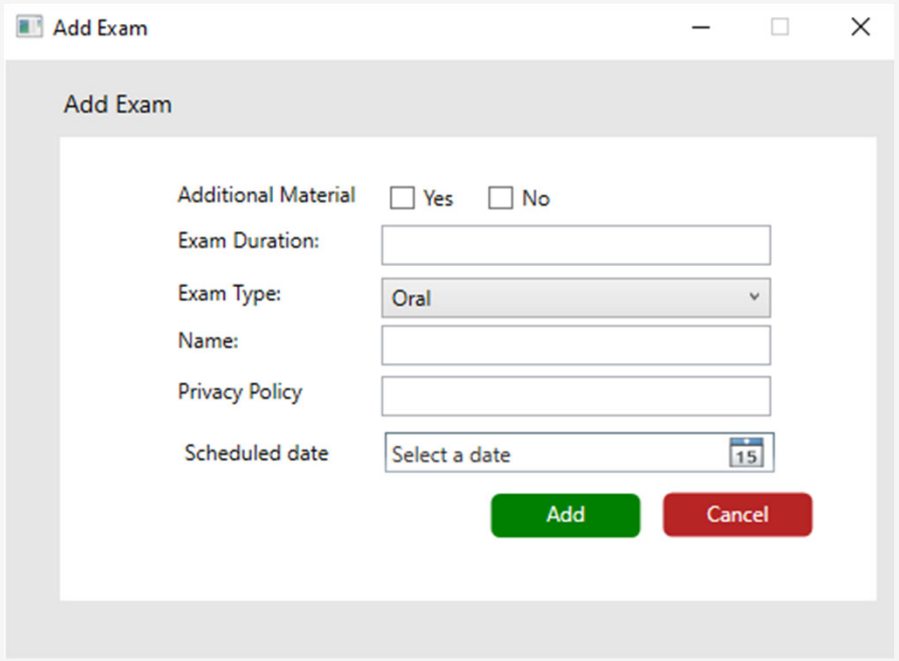

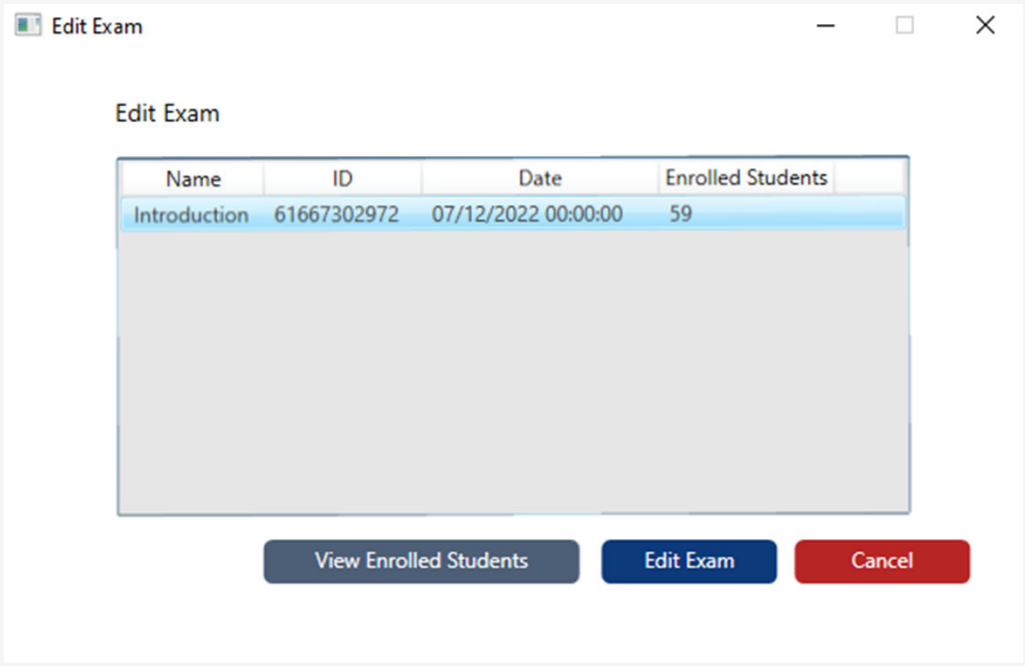

LMS Integration and Synchronization Tools

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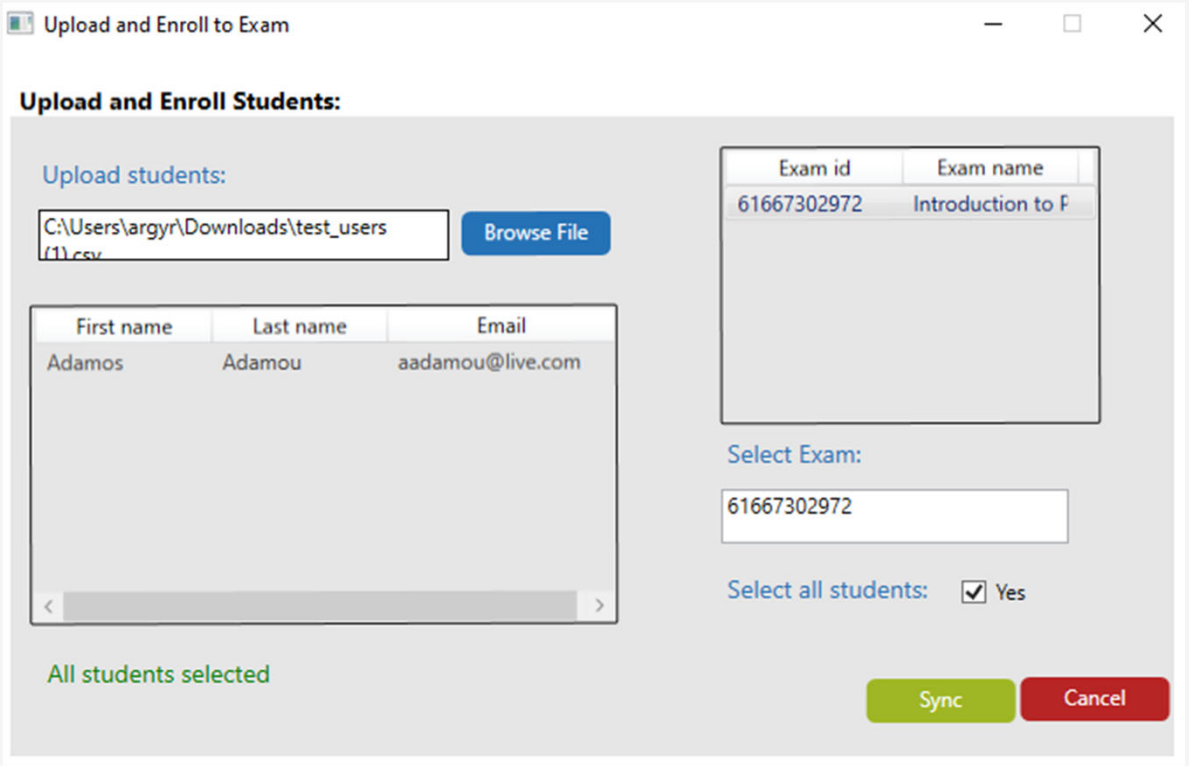

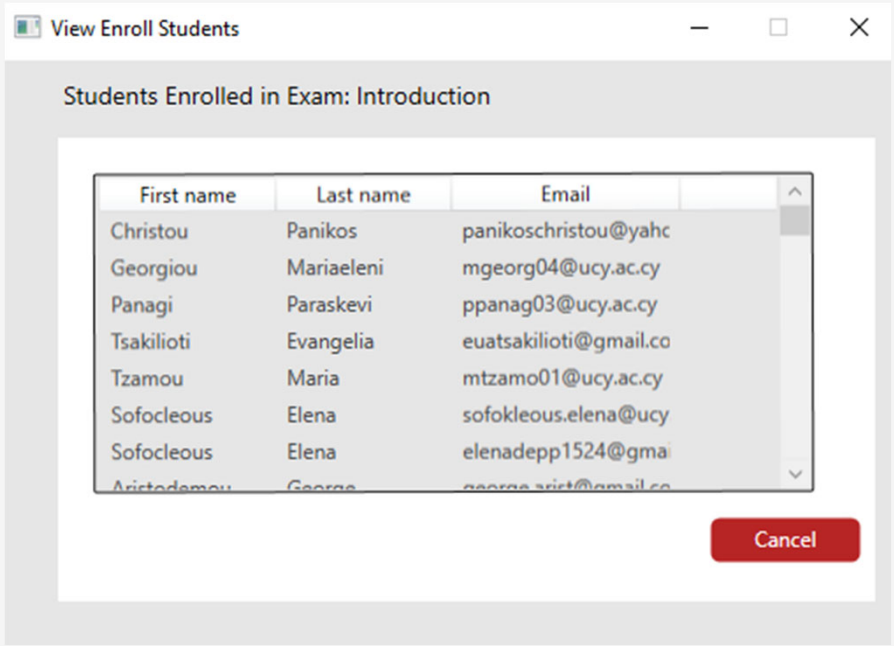

TRUSTID Backend – Application Programming Interface

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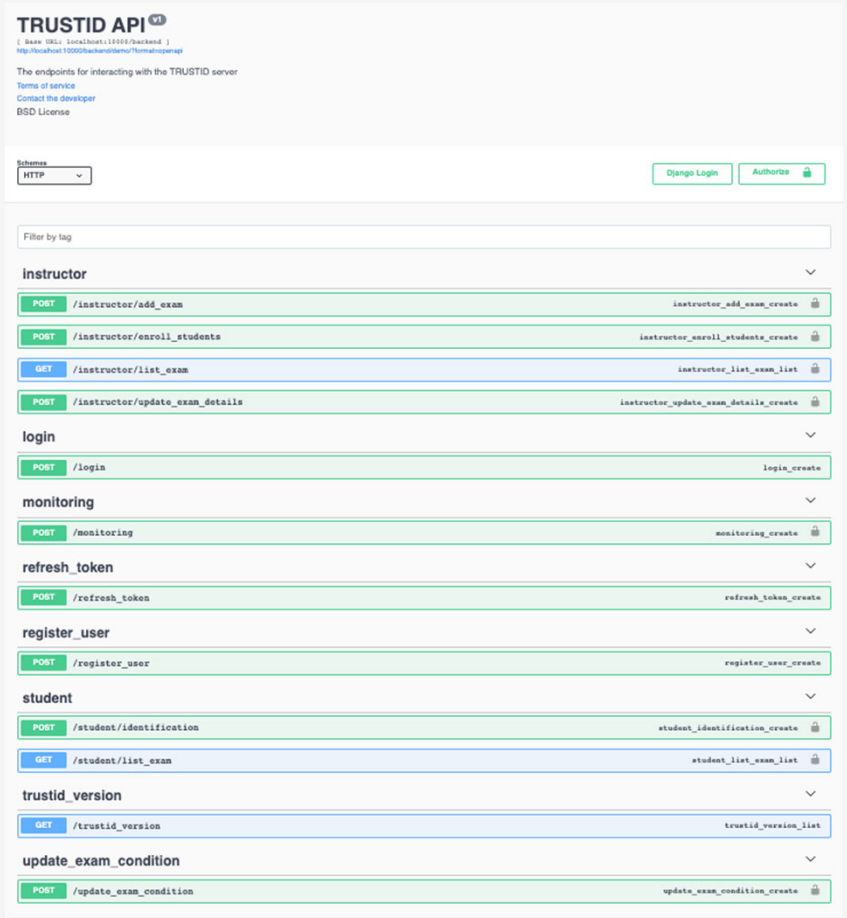

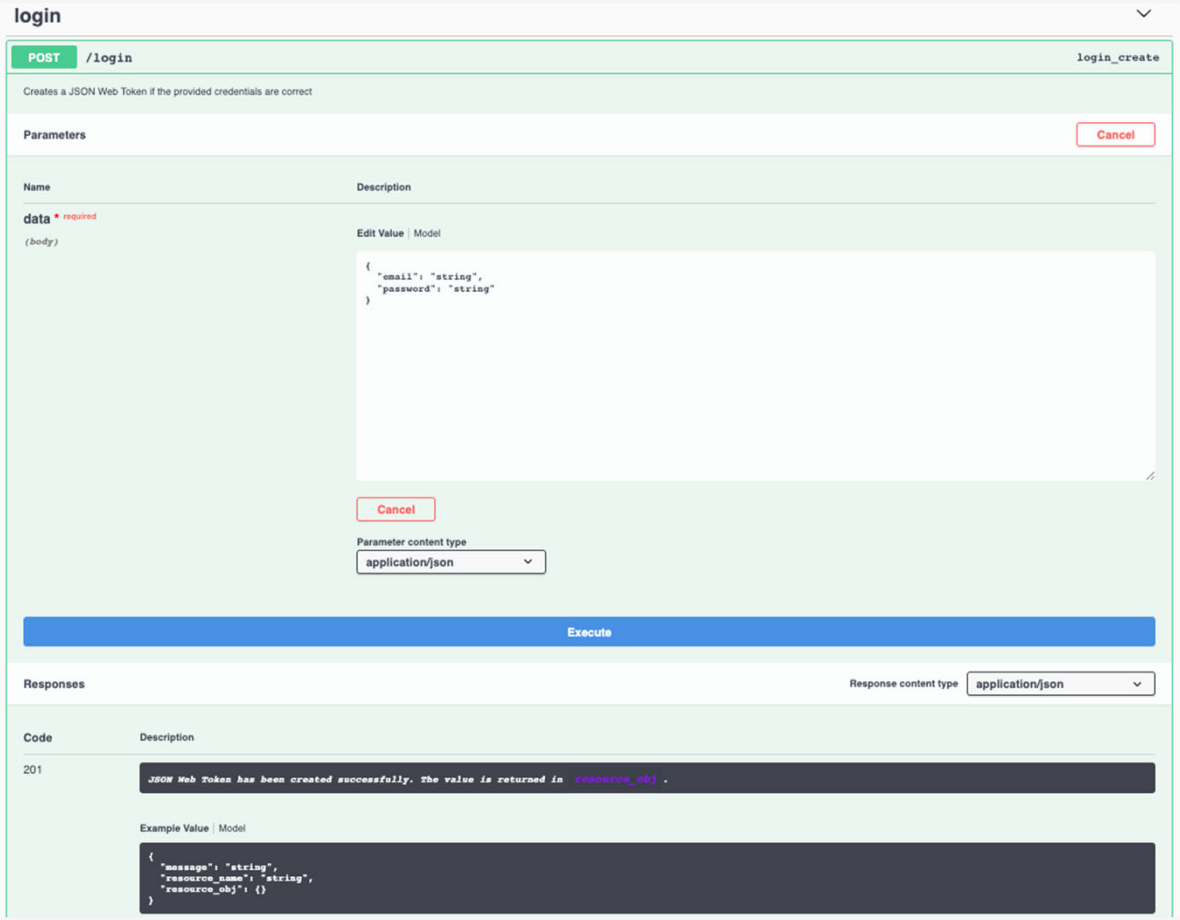

Web API – Documentation

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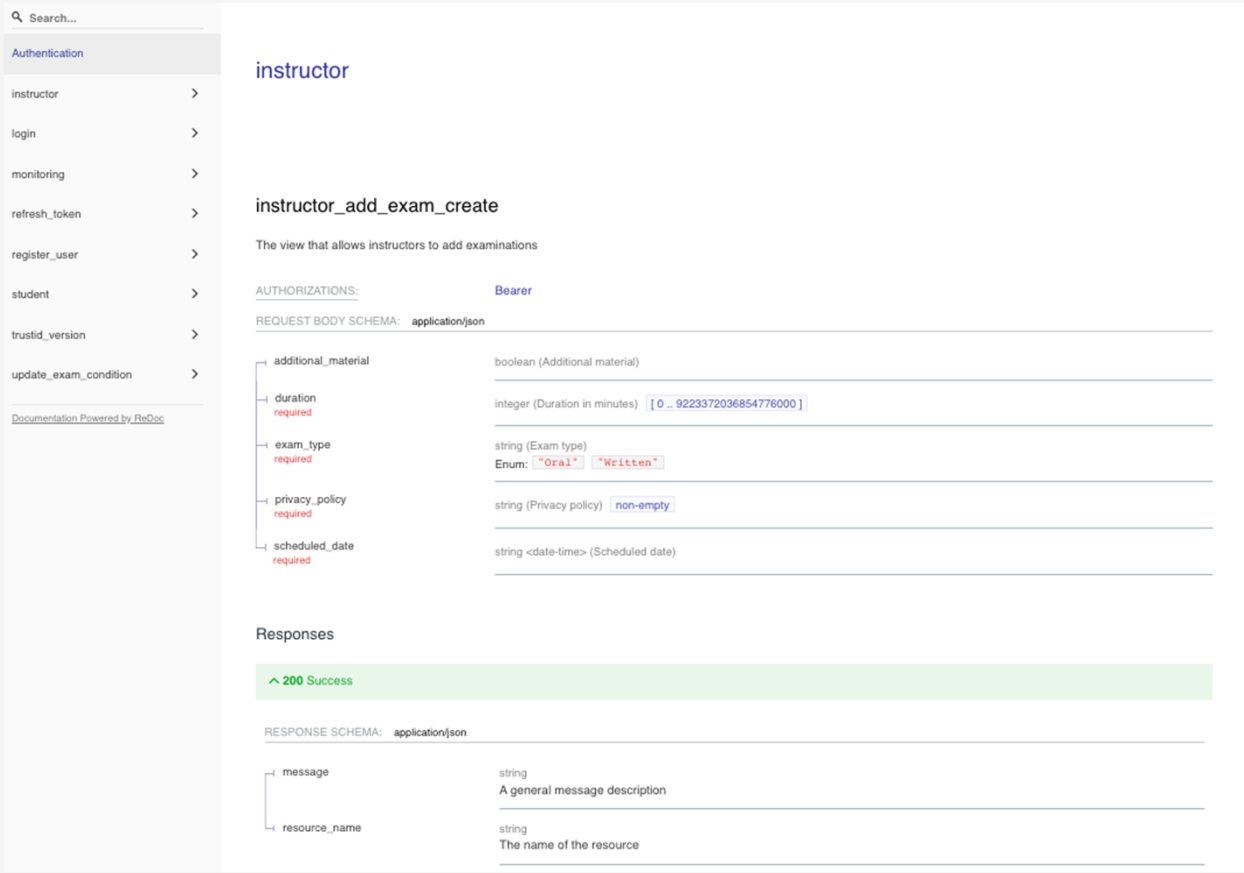

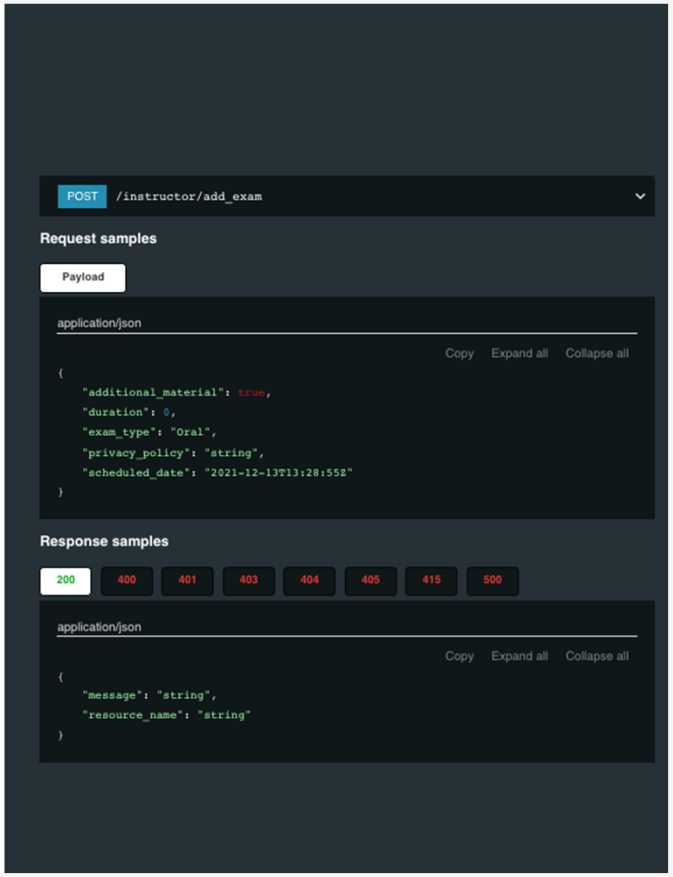

Wallet for biometrics models

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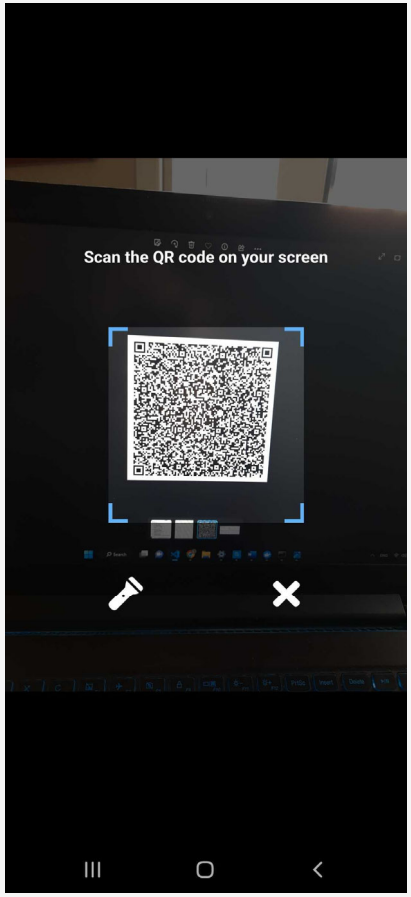
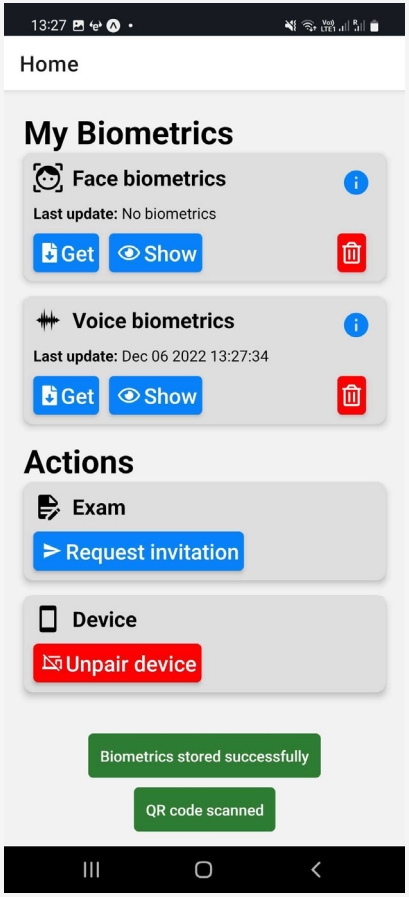
- Pair mobile application with TRUSTID system to fetch and store the biometric models locally





Wallet for biometrics models

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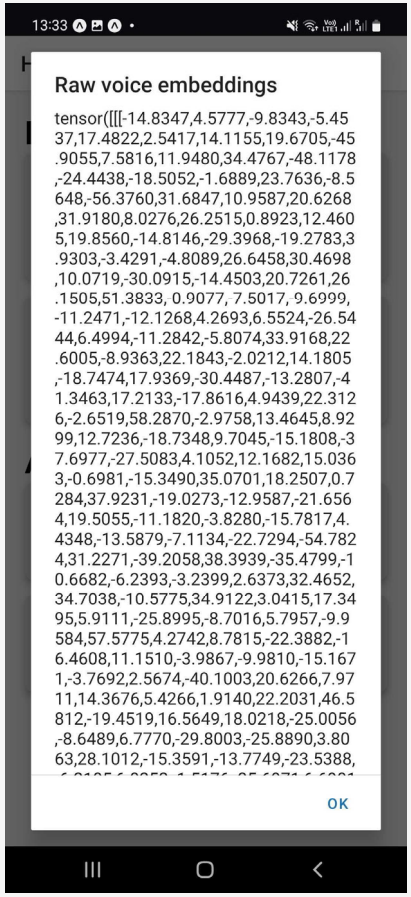
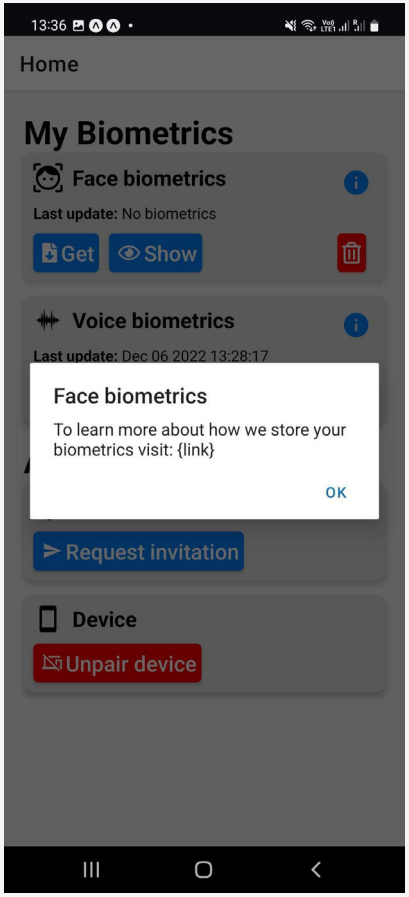
- Management of biometrics models
  - Display
  - Delete
  - Privacy policy





Wallet for biometrics models

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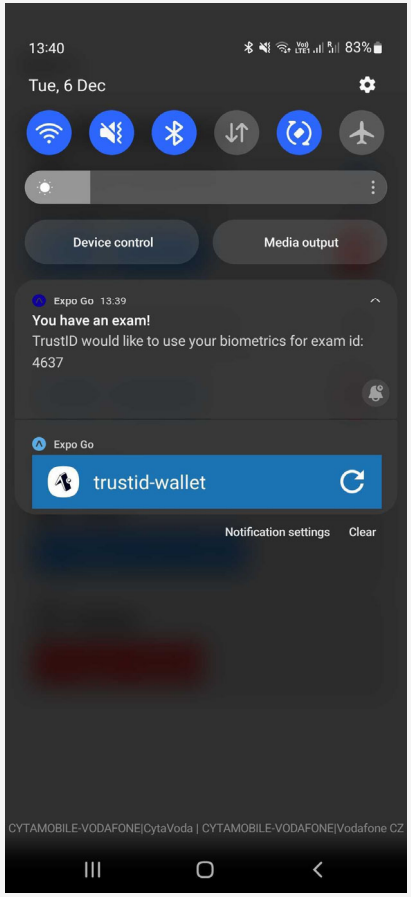
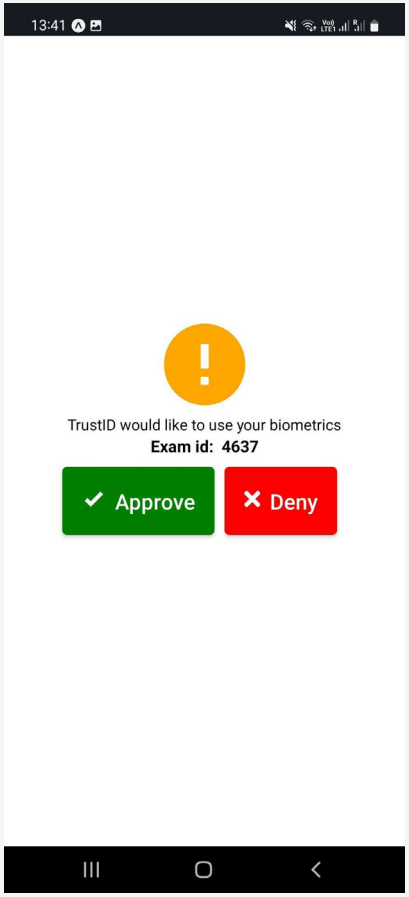
- Push notification for approval of sharing of biometrics models during online examination





User Study Scenarios for Proof of Concept 2

Aims of the Evaluation

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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

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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
- *Duration:* ~20-30 minutes

Preparation phase

- Invite participants through the following URL:
  - https://trustid-project.eu/participate_upat.php
  - https://trustid-project.eu/participate_uc.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

Study Design 2/2

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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

Resilience to Impersonation Attacks

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Summary of the sample and the collected data

Mock Examination Type	# of Participants	# of Face Images	Audio Samples Length (in minutes)
Online Written	65	1804	75.68
Online Oral	68	1530	123.47
Totals	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)
Online Written	24	391	31.04
Online Oral	32	582	52.73
Totals	56	973	83.77

Summary of the results for each identification case

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

Questionnaire Results

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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

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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/

Thank you

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INTELLIGENT AND CONTINUOUS ONLINE STUDENT IDENTITY MANAGEMENT

Improving Security and Trust in European Higher Education Institutions