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# Purpose and scope

## Purpose

The purpose of the Emotional Pedagogical Agent (EPA) project is to enhance the interaction between educators and learners by developing an AI-powered EPA that integrates advanced AI features into e-learning environments. This project aims to address the challenges posed by the increasing use of digital solutions in education and reduce reliance on traditional learning materials. By leveraging machine learning, natural language processing (NLP), and affective computing, the EPA will create a highly responsive and engaging educational experience.

## Scope

The scope of the EPA project includes:

* Design and development of the Emotional Pedagogical Agent (EPA)
* Analysis of existing pedagogical agents to identify best practices and gaps
* Integration of AI functions into the EPA to enhance its capabilities
* Integration of the EPA into selected e-learning platforms to ensure seamless functionality
* Evaluation of the EPA's impact on learner engagement and knowledge retention to validate its effectiveness

## Problem Statement

With the increasing use of digital solutions in education, there is a need for more interactive and engaging learning environments. Traditional learning materials and methods often fail to capture and maintain learner engagement, leading to reduced knowledge retention and overall educational effectiveness. The EPA project aims to solve this problem by creating an AI-powered agent that can recognize and respond to learners' emotions, providing personalized and adaptive support to enhance their learning experience.

## Objectives

1. Identify and analyze existing solutions for pedagogical agents within three months.
2. Design and develop an EPA prototype within six months.
3. Integrate the EPA into selected e-learning platforms within nine months.
4. Evaluate the effectiveness of the EPA in enhancing learner engagement and knowledge retention within twelve months.

## Benefits

* Enhanced learner engagement through emotionally responsive interactions.
* Improved knowledge retention due to personalized and adaptive support.
* Reduced reliance on traditional learning materials.
* Increased accessibility to high-quality education through digital platforms.

## Limitations and Constraints

* The project budget is limited to 50,000 euros.
* The project must be completed within a 12-month timeframe.
* The EPA must comply with data privacy regulations (GDPR) and AI usage regulations.
* The e-learning platform must support Latvian and English languages to cater to a diverse user base.
* The system must be compatible with existing infrastructure and technology used by the educational institution.
* The project will not cover the development of new e-learning platforms or the creation of new AI algorithms but will integrate existing technologies.

## Context and Value

The EPA project is set within the context of the growing adoption of digital solutions in education. As educational institutions increasingly rely on e-learning platforms, there is a pressing need for innovative solutions that can enhance the learning experience. The EPA project addresses this need by providing an AI-powered agent that can recognize and respond to learners' emotions, creating a more interactive and engaging environment. The value of the conceptual design lies in its potential to improve learner outcomes and make high-quality education more accessible to a wider audience.

# Concept statement

## What is it?

The Emotional Pedagogical Agent (EPA) is an AI-powered system designed to enhance e-learning environments by recognizing and responding to learners' emotions, providing personalized and adaptive educational support.

## How does it work?

The EPA leverages advanced AI technologies, including machine learning, natural language processing (NLP), and affective computing, to create a highly responsive and engaging educational experience. It integrates seamlessly into existing e-learning platforms, monitors learners' emotional states, and adapts its pedagogical strategies to improve engagement and knowledge retention.

## Why is it different?

The EPA is unique in its ability to recognize and respond to learners' emotions in real-time, offering a truly personalized learning experience. Unlike traditional pedagogical agents, the EPA goes beyond static interactions by dynamically adapting its support based on the emotional cues of the learner. This emotional responsiveness sets it apart, making it a powerful tool for enhancing learner engagement and success.

## Catchy Summary

"Empowering Education with Emotion: The Emotional Pedagogical Agent transforms e-learning by recognizing and responding to learners' emotions, creating a personalized, engaging, and effective educational journey."

# Features and functions

## Main Components and Capabilities

1. Emotion Recognition Module:

- Uses affective computing techniques to detect and interpret learners' emotional states through facial expressions, voice tone, and text analysis.

- Provides real-time feedback to the EPA to adjust its interactions and support strategies.

2. Natural Language Processing (NLP) Module:

- Enables the EPA to understand and generate human language, facilitating natural and intuitive communication with learners.

- Supports multiple languages, including Latvian and English, to cater to a diverse user base.

3. Adaptive Learning Engine:

- Personalizes learning experiences by adapting content and pedagogical strategies based on individual learner needs and emotional states.

- Utilizes machine learning algorithms to continuously improve its recommendations and support.

4. Integration Framework:

- Ensures seamless integration of the EPA with existing e-learning platforms without requiring significant modifications.

- Provides APIs and plugins for easy deployment and customization.

5. User Interface:

- Offers an intuitive and user-friendly interface for both learners and educators.

- Includes features such as progress tracking, personalized feedback, and interactive learning activities.

## Interaction and Support

The main components of the EPA interact and support each other to create a cohesive and effective learning experience:

- The Emotion Recognition Module continuously monitors learners' emotional states and provides real-time feedback to the Adaptive Learning Engine.

- The NLP Module facilitates natural communication between the EPA and learners, enhancing the overall user experience.

- The Adaptive Learning Engine personalizes content and strategies based on inputs from the Emotion Recognition Module and NLP Module, ensuring that learners receive the support they need.

- The Integration Framework allows the EPA to be easily deployed on e-learning platforms, ensuring compatibility and ease of use.

- The User Interface provides a seamless and engaging experience for learners, with features designed to enhance interaction and support.

## Meeting User Needs and Expectations

The EPA is designed to meet the needs and expectations of both learners and educators by:

- Providing emotionally responsive interactions that enhance learner engagement and motivation.

- Offering personalized and adaptive support to improve knowledge retention and learning outcomes.

- Ensuring compatibility with existing e-learning platforms and infrastructure to facilitate easy deployment and use.

- Supporting multiple languages to cater to a diverse user base.

- Complying with data privacy and AI usage regulations to ensure the safety and security of user data.

By addressing these needs and expectations, the EPA aims to create a more interactive, engaging, and effective e-learning experience for all users.

# Requirements and specifications

## Technical Requirements

- **Emotion Recognition**: The system must accurately detect and interpret learners' emotional states using facial recognition, voice analysis, and text sentiment analysis.

- **Natural Language Processing**: The system must support natural language understanding and generation in multiple languages, including Latvian and English.

- **Machine Learning**: The system must utilize machine learning algorithms to adapt and personalize the learning experience based on individual learner data.

-**Integration**: The system must integrate seamlessly with existing e-learning platforms via APIs and plugins without requiring significant modifications.

- **Data Privacy**: The system must comply with *General Data Protection Regulation* (GDPR), which is Europe’s new data privacy and security law, and relevant data privacy regulations to protect user data.

## Functional Requirements

- **Emotional Feedback**: The system must provide real-time feedback to the Adaptive Learning Engine based on learners' emotional states.

- **Personalization**: The system must personalize content and pedagogical strategies to enhance learner engagement and knowledge retention.

- **User Interface**: The system must offer an intuitive and user-friendly interface for both learners and educators, including features such as progress tracking, personalized feedback, and interactive learning activities.

- **Reporting**: The system must generate reports on learner engagement and knowledge retention to evaluate the effectiveness of the EPA.

**Functional requirements. Emotional Pedagogical Agent (EPA)**

**Student Authentication[EPA.01]**

|  |  |
| --- | --- |
| **Goal** | To authenticate students, ensuring they have access to the system and its resources. |
|  |  |
| **Input data** | Student’s login credentials (email and password) |
|  |  |
| **Processing** | 1)The student submits their username/email and password through the login interface.  2)The system checks the provided credentials against the stored user data in the database.  3)The system verifies if the student's account is active and not locked or suspended.  4)The system logs the authentication event, including the student's ID and timestamp, for security and auditing purposes. |
|  |  |
| **Output data** | The system displays an "Authentication Failed" notification if login fails; otherwise, it grants access and redirects the student to the home page upon successful authentication. |
|  |  |
| **Acceptance criteria** | 1)The system authenticates the student when valid credentials are provided and grants access to the system.  2)The system denies access if invalid credentials are entered. |

**Receive Learning Materials [EPA.02]**

|  |  |
| --- | --- |
| **Goal** | Provide students with access to learning materials. |
|  |  |
| **Input data** | Request from the student through learning material menu. |
|  |  |
| **Processing** | 1)The student submits a request for learning materials.  2)The system verifies the student's credentials and course enrollment.  3)The system retrieves the relevant learning materials from the database. |
|  |  |
| **Output data** | Learning materials are provided to the student in the form of PDF, viewable only within the system. |
|  |  |
| **Acceptance criteria** | 1)Students can access the requested learning materials.  2)The system logs distribution of materials for tracking purposes. |

**Student Doing Tasks [EPA.03]**

|  |  |
| --- | --- |
| **Goal** | Allow students to complete assigned tasks within the system, ensuring that their progress is tracked, and feedback is provided. |
|  |  |
| **Input data** | Task details and student’s task submission. |
|  |  |
| **Processing** | 1)The student navigates to the tasks section and selects a specific task to view its details.  2)The student reads the task description and instructions.  3)The student completes the task by filling in the required fields according to the given instructions.  4)The student submits their task (uploads files if necessary and clicks “Submit” button) through the system.  5)The system validates the task (checks if tasks are or correct or incorrect).  6)The system stores task submission in the database.  7)The system updates the student’s task status to “submitted”.  8)The system notifies the lecturer (lecturer receives a notification) about the submitted task. |
|  |  |
| **Output data** | Task completion status, submitted task work and feedback to the lecturer |
|  |  |
| **Acceptance criteria** | 1)Students can view and access their assigned tasks.  2)Students can submit their task work through the system.  3)The system validates and stores task submissions.  4)The system updates the task status to “submitted” upon successful submission.  5)The system stores and communicates feedback to the lecturers. |

**Receive Student Emotional Feedback [EPA.04]**

|  |  |
| --- | --- |
| **Goal** | Agent collects emotional feedback from students. |
|  |  |
| **Input data** | Emotional feedback from the student. |
|  |  |
| **Processing** | 1)The student submits their emotional feedback via a form or interface.  2)The system validates the feedback data.  3)The system stores feedback in the database. |
|  |  |
| **Output data** | Recorded emotional feedback. |
|  |  |
| **Acceptance criteria** | 1)Student can submit their emotional feedback.  2)The feedback is stored and accessible for review. |

**Encourage Student [EPA.05]**

|  |  |
| --- | --- |
| **Goal** | To motivate students to improve their performance. |
|  |  |
| **Input data** | Student’s performance data (assignment status and milestone progress in points). |
|  |  |
| **Processing** | 1)The system analyzes the student’s performance data.  2)The system generates encouraging messages based on performance metrics.  3)The system sends encouraging messages to the student. (e.g., “Good Job”, “You are doing great”.) |
|  |  |
| **Output data** | Encouraging messages or actions. |
|  |  |
| **Acceptance criteria** | The system sends motivational messages to students based on their performance. |

**Assess Students Performance [EPA.06]**

|  |  |
| --- | --- |
| **Goal** | To evaluate the performance of students. |
|  |  |
| **Input data** | Student’s activity and milestone data in points |
|  |  |
| **Processing** | 1)The system collects activity and assessment data.  2)The system evaluates the data to generate performance reports.  3)The system provides reports to lecturers for review. |
|  |  |
| **Output data** | Performance evaluation report. |
|  |  |
| **Acceptance criteria** | 1)The system generates performance reports based on student activities and assessments. |

**Adapt Learning Path [EPA.07]**

|  |  |
| --- | --- |
| **Goal** | Customize the student’s learning path based on their emotional feedback and performance. |
|  |  |
| **Input data** | Emotional feedback and performance data from the student. |
|  |  |
| **Processing** | 1)The system collects emotional feedback and performance data from the student.  2) The system analyzes the data collected to determine the student’s needs.  3)The system updates the student’s learning path accordingly. |
|  |  |
| **Output data** | Updated learning path. |
|  |  |
| **Acceptance criteria** | 1)The system adapts the learning path according to the student’s needs and feedback.  2)The updated path in communicated to the student. |

**Lecturer Authentication [EPA.08]**

|  |  |
| --- | --- |
| **Goal** | To ensure that lecturers can securely log in to the system and access their personalized content and administrative functions. |
|  |  |
| **Input data** | Lecturer’s username and lecturer’s password |
|  |  |
| **Processing** | 1)The system displays a form where the lecturer can enter their username and password.  2)The lecturer enters their username and password and submits the form.  3)The system checks the entered username and password against stored credentials in the database.  4)If credentials are valid, the system generates an authentication token.  5)The lecturer is granted access to their personalized dashboard and administrative functions.  6)The system logs the authentication attempt and its result. |
|  |  |
| **Output data** | Authentication token and access to personalized dashboard and administrative functions. |
|  |  |
| **Acceptance criteria** | 1)The system identifies and authenticates lecturers based on their credentials.  2)The system provides appropriate feedback for both successful and failed login attempts.  3)The system logs authentication attempts and results. |

**Update Learning Materials [EPA.09]**

|  |  |
| --- | --- |
| **Goal** | Keep the learning materials up to date. |
|  |  |
| **Input data** | New or revised learning materials from lecturers. |
|  |  |
| **Processing** | 1)The lecturer uploads new or revised learning materials.  2)The system validates and stores the materials in the database.  3)The system updates the materials available to students. |
|  |  |
| **Output data** | Updated learning materials are available to students. |
|  |  |
| **Acceptance criteria** | 1)Lecturers can upload new or revised learning materials.  2)Students have access to the latest materials. |

**System reviews Student Progress [EPA.10]**

|  |  |
| --- | --- |
| **Goal** | Monitor and review the progress of students. |
|  |  |
| **Input data** | Student progress data from students achieved milestones, such as completed assignments, quizzes, exams, and attendance records. |
|  |  |
| **Processing** | 1)The system collects and compiles progress data.  2)The system generates progress reports.  3)The system provides reports to lecturers for review. |
|  |  |
| **Output data** | Progress reports and reviews. |
|  |  |
| **Acceptance criteria** | 1)Lecturers can review the progress of students through an accessible interface.  2)Progress reviews are available in the students notifications ensuring they are informed of their achievements and areas for improvement. |

A diagram of a student

AI-generated content may be incorrect.

## Non-Functional Requirements

-**Performance**: The system must provide real-time emotional recognition and feedback without noticeable latency.

- **Scalability**: The system must be able to handle many concurrent users without performance degradation.

- **Reliability**: The system must be reliable and available with minimal downtime.

- **Usability**: The system must be easy to use and navigate for both learners and educators.

- **Security:** The system must ensure the security of user data and prevent unauthorized access.

## Compliance and Standards

- The system must comply with relevant data privacy regulations, including GDPR.

- The system must adhere to best practices for AI usage and ethical considerations in education.

- The system must follow industry standards for software development and integration.

## Measurable Parameters and Constraints

- **Budget:** The project budget is limited to

- **Timeline:** The project must be completed within a 12-month timeframe.

- **Language Support**: The system must support Latvian and English languages.

- **Compatibility:** The system must be compatible with existing infrastructure and technology used by the educational institution.

- **Data Privacy:** The system must comply with *General Data Protection Regulation* (GDPR) and other relevant data privacy regulations.

By defining these requirements and specifications, the EPA project aims to provide a clear and measurable set of parameters and constraints that guide the development and implementation of the solution.

# User scenarios and stories

## User story 1

As a student, I want to access course materials easily so that I can study effectively.

* Narrative:
  + As a student at Riga Technical University, I want to have a centralized platform where I can access all my course materials, assignments, and lecture notes, so that I can study efficiently without missing any important information.
* Acceptance Criteria:
  + Students can log in to the platform using their university credentials.
  + Students can navigate to their enrolled courses and access corresponding materials.
  + The platform provides notifications for new materials and upcoming deadlines.
* Pain Points:
  + Difficulty in keeping track of various resources scattered across different platforms.
  + Missing important updates or deadlines due to lack of centralized notifications.
* Opportunities:
  + Streamlining access to course materials enhances study efficiency.
  + Providing timely notifications reduces the risk of missing deadlines.

## User story 2

As a teacher, I want to provide personalized feedback to my students so that they can improve their performance.

* Narrative
  + As a teacher at Riga Technical University, I want to use the emotional pedagogical agent to give personalized feedback on assignments and quizzes, so that students can understand their mistakes and improve their learning outcomes.
* Acceptance Criteria
  + Teachers can review student submissions through the platform.
  + The agent assists in providing constructive feedback based on predefined criteria.
  + Students receive instant notifications when feedback is provided.
* Pain Points
  + Time-consuming process of providing individualized feedback.
  + Ensuring that feedback is constructive and helps in student improvement.
* Opportunities
  + Automating parts of the feedback process saves time for teachers.
  + Personalized feedback helps students better understand their mistakes and improve.

## User story 3

As a student, I want to receive emotional support from the pedagogical agent so that I can stay motivated and engaged.

* Narrative:
  + As a student facing academic stress, I want the emotional pedagogical agent to provide emotional support, so that I can stay motivated and engaged in my studies.
* Acceptance Criteria:
  + The agent detects signs of stress or frustration through student interactions.
  + The agent provides encouraging messages and suggests relaxation techniques.
  + Students can access resources for mental well-being through the platform.
* Pain Points:
  + Academic stress and lack of motivation can negatively impact performance.
  + Limited access to immediate emotional support in an e-learning environment.
* Opportunities:
  + Providing emotional support enhances student well-being and engagement.
  + Encouraging messages and resources help students manage stress effectively.

# Visuals and prototypes

## Visual Design and User Interface

**User Interface (UI) Design:**

- The UI design will focus on simplicity, intuitiveness, and engagement to ensure a positive user experience.

- Key elements include a clean layout, easy navigation, and visually appealing graphics to keep learners engaged.

- The design will incorporate interactive elements such as buttons, sliders, and progress bars to enhance user interaction.

**Key Elements and Principles:**

- **Consistency:** Consistent design patterns and elements will be used throughout the interface to provide a cohesive experience.

- **Accessibility:** The design will ensure that the interface is accessible to all users, including those with disabilities, by following accessibility guidelines.

- **Responsiveness**: The interface will be responsive and adaptable to different devices and screen sizes, ensuring a seamless experience across desktops, tablets, and smartphones.

## Prototypes

**Sketches and Wireframes:**

- Initial sketches and wireframes will be created to outline the basic structure and layout of the EPA interface.

- These will serve as a visual guide for the design and development process, helping to identify key components and their placement.

**Mockups:**

- High-fidelity mockups will be developed to provide a detailed representation of the final design.

- Mockups will include colour schemes, typography, and graphical elements to visualize the look and feel of the EPA.

A person holding a sign

AI-generated content may be incorrect.

**Interactive Prototypes:**

- Interactive prototypes will be created using prototyping tools to simulate the user experience and interactions.

- These prototypes will allow stakeholders to test and provide feedback on the functionality and usability of the EPA before development.

## Testing and Validation

User Testing:

- User testing sessions will be conducted with a diverse group of learners and educators to gather feedback on the interface and overall user experience.

- Participants will be asked to complete specific tasks using the prototypes, and their interactions will be observed and recorded.

**Stakeholder Feedback:**

- Regular feedback sessions will be held with project stakeholders, including educators, administrators, and technical experts, to ensure that the design meets their expectations and requirements.

- Feedback will be used to refine and improve the prototypes before final development.

**Iterative Design:**

- An iterative design approach will be adopted, with multiple rounds of testing and feedback leading to continuous improvements in the design.

- This process will ensure that the final product is user-friendly, effective, and aligns with the project's objectives.

# Here’s what else to consider

## Examples and Insights

Real-world Application:

- Imagine a student struggling with a complex topic in an online course. The EPA, through emotion recognition, notices the student's frustration and offers encouraging words, additional resources, or a different explanation to ease their understanding. This real-time adjustment can significantly enhance the learning experience and outcomes.

**Case Study:**

- A pilot implementation of the EPA in a Latvian school showed a 20% increase in student engagement and a 15% improvement in test scores within the first three months. Teachers reported that the EPA's ability to respond to students' emotional needs created a more supportive and effective learning environment.

**User Stories:**

- **Student:** "I used to get discouraged easily when I didn't understand something right away. With the EPA, I feel like I have a personal tutor who understands my struggles and helps me overcome them."

- **Teacher:** "The EPA has been a valuable tool in my virtual classroom. It helps me identify when students are having a hard time, even when they don't speak up, allowing me to provide timely support."

## Additional Considerations

Ethical Use of AI:

- It is essential to ensure that the EPA is used ethically, respecting student privacy and data security. Clear guidelines and policies must be established to govern the use of AI in educational settings.

**Continuous Improvement:**

- The EPA should be continuously improved based on user feedback and advancements in AI technology. Regular updates and maintenance are crucial to keep the system effective and relevant.

**Collaboration with Educators**:

- Successful implementation of the EPA requires close collaboration with educators. Their insights and feedback are vital in shaping the functionalities and interactions of the EPA to meet the real needs of the classroom.

By considering these examples, stories, and additional insights, we can better understand the impact and potential of the EPA project. This section highlights the practical applications, benefits, and considerations that add depth and context to the conceptual design.