Engineer Training on New Ways: Imagine, Create, Innovate!

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***MISSION*:** *Imagine, create, innovate! The mission of this European Year is to promote a creative and innovative approach to different fields of human activity. We are to demonstrate here what hidden possibilities there are, and what possibilities are still to be created in the teaching of the subject DESIGNING INFORMATION SYSTEMS (IS's) for students to notice, understand and implement this process. It is an important aim to implant an urge in students to come up with imaginative ideas and, using the same process, turn them into a finished product in all areas of their lives.*

In the process of designing and implementing information systems, developers progress from imagination through creation to innovation. They need to answer to a real-life need by implementing an imaginative idea into reality, using a system-based approach, the methods of mental modelling, and the support of computer technology. The main goal all through this process is for the end product to be as effective and easy-to-use as possible, while meeting all applicable requirements.

Keywords: *Engineer Training, designing and implementing information systems, intelligent learning.*

INFORMATION SYSTEMS (IS):

An information system uses as a resource data and information which properly processed provides useful new information for a given task. An information system's main goal is to produce information, that is, to produce purposeful messages that mean a novelty for the user, dissolve uncertainty, and support them in their tasks or decisions.

Our goals: To present the development of information systems as a special way of problem-solving. To make evident the importance of being methodical. To prepare the design of information systems using an object-oriented methodology. To get to know the available CASE tool, and use it to prepare and produce IS plans. To support a project-like approach.

Contents:

- Goals of IS's, their design, definition, outlining their contents, discovering their elements, and connection between elements.
- Features of IS's, developing IS's
- The philosophy (structural or object-oriented approach), models (chronology, lifecycle, and types), methodologies (policy), and tools (techniques – CASE, UML) of developing information systems.
- Methodology and models of object-oriented design: Requirements Model, Static Model, Dynamic Model, Functional Model. Diagrams that support the description of models. Preparing a plan for schematic designs.

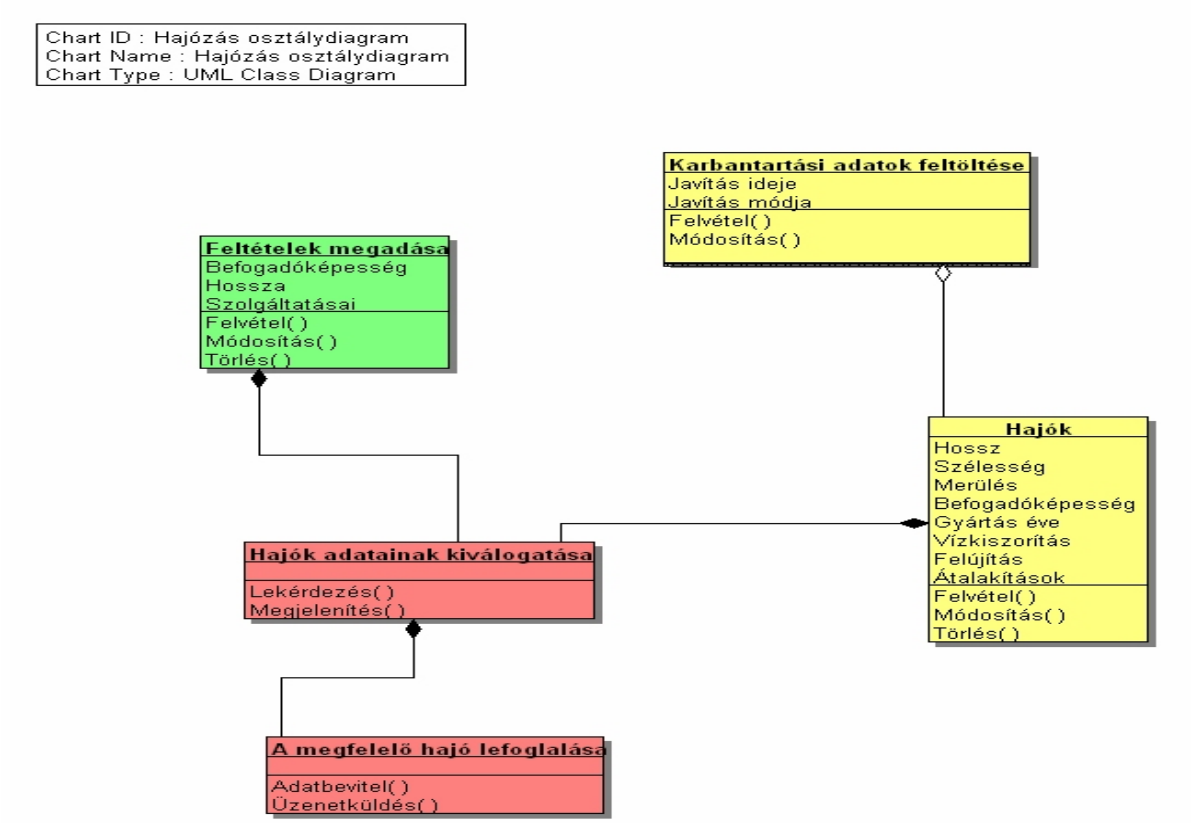
Requirements: After completing the tasks students should be able to identify the main characteristics of a system, as well as its static and dynamic elements. They are supposed to have routine knowledge of how to use a CASE system, and of the services of information systems. They should be fluent in the process of designing information systems, from creating models of the solution, through preparing documentation to the end product.

Competencies to be cultivated:

Apart from the possibilities that spur from the subject itself, we promote the development and cultivation of special competencies. Analysis is needed for this, as these skills and competencies will not emerge automatically with acquiring factual knowledge of the subject, only through conscious pedagogical and methodological efforts.

Designing information systems is impossible without the skills of ***intelligent learning***, *understanding deeper context*, analysing connections between elements of a system, which forms part of an object-oriented technology.

The object model of an IS should contain a class diagram that represents and interprets the elements and the connections between them.



Our task is to develop the skills of *applicable knowledge*, *the applying of knowledge to real-life situations*, as an information system is always the solution of a real-life problem with the support of computer technology. The tasks direct the students through a supervised project of designing an information system, using individual ideas and tools. In the planning phase each student draws up the plan of an information system that fits into their field of interests, knowledge, and current tasks, so they can realise their own ideas, dreams and imagination. Each task consists of five units to avoid flaws in system design, and to promote *feedback and supervision* from themselves and from

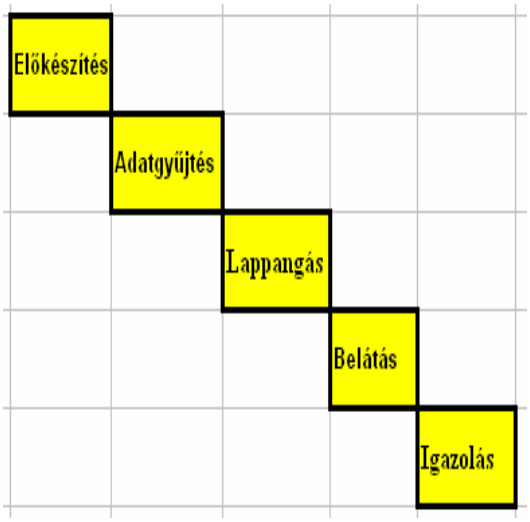
the tutors. Accomplishing the tasks requires *application of the acquired knowledge in different situations*.

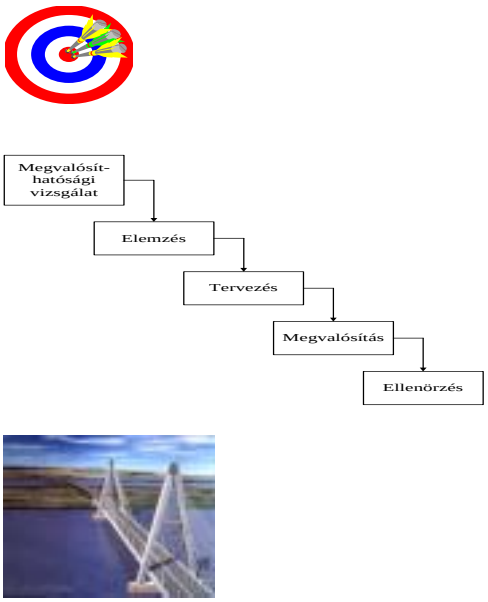
The most important goal of teaching computer technology is to make ***digital literacy*** a routine skill. Elements of digital literacy make it possible for the user to benefit from the features that computers provide, as e.g. the use of text and chart editors and other user applications. The knowledge of Internet and networks in general is also important, as are multimedia applications. Some knowledge of these is brought on from earlier studies. We build on, and also broaden this knowledge when designing IS's. When using the internet it is important to emphasise that a smaller amount of information arrived at by purposeful, narrowed-down searching is worth more than an abundant quantity of information. Using the eGeo educational portal also serves as a method of making ***digital literacy*** a routine skill. This is an educational support system based on the Moodle framework, incorporating some elements of web2.0. Some services of this system will be used here for demonstration.

Improving ***problem-solving skills*** is a life-long task. According to Guilford creation is a determined process, which is limited from start by the goals that are set out (1967). In this interpretation creativity is the same as problem-solving (or, in a sense, system design)

When developing creative thinking one should remember that thinking is a time-consuming activity.

The time-span of the thinking process can be followed on two levels:





Preparation – Collecting Data – Latency – Realisation – Justification

Feasibility Study – Analysis – Planning – Implementation - Verification

Creative thinking

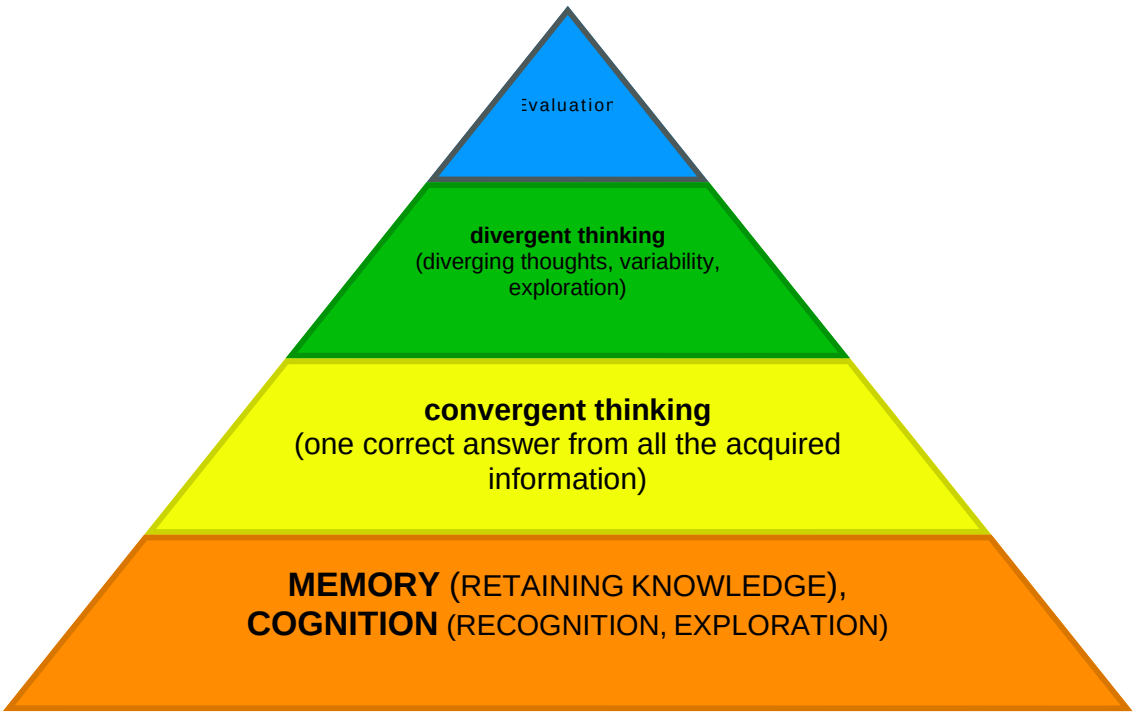
Creativity is the process of forming notions or hypotheses, trying them, and communicating the results. Characteristics of creative thinking are: vivid imagination, intuition, ingenuity, originality, divergent thinking, flexibility of thought, searching for new solutions, receptiveness for the unknown, sensibility for problems.

Cognitive skills:

General cognitive skills: interpretation of written text, general memory, overall cognitive speed, perception skills, observation skills, concentration skills, ability to seek out the substance, analytical thinking, inductive and deductive thinking, swiftness of processing information, associative skills, conclusive thinking, ability to represent problems, ability to form chains of conclusions.

Specific mental abilities: trained perception, visualisation, transformation skills, and abstraction skills.

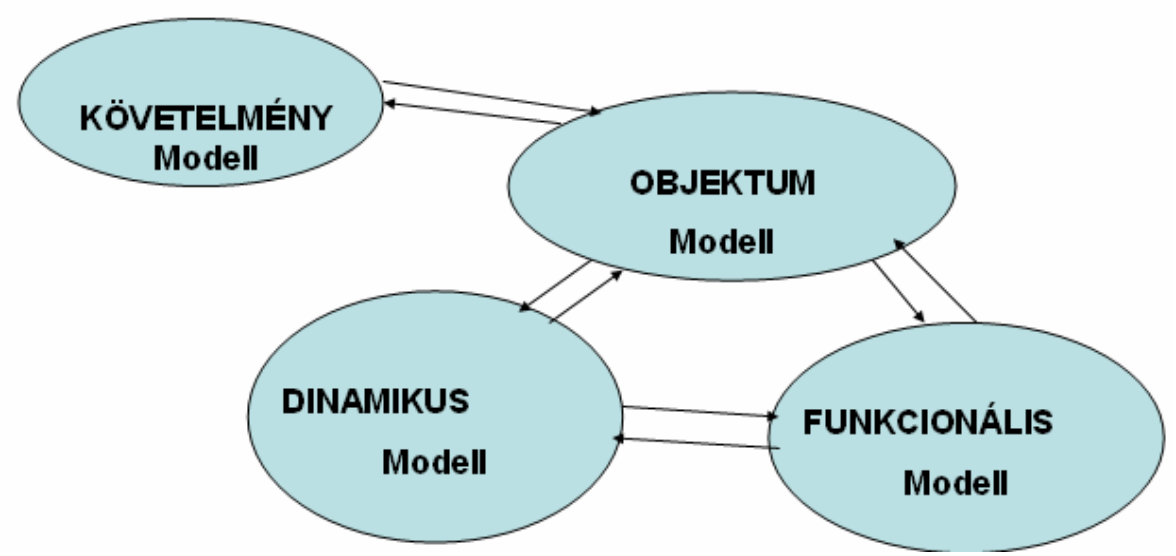
Creativity requires the conscious use of thought processes.



Let me emphasise the possibilities of improvement for the elements of divergent thinking, as I think this is indispensable for creative thinking, and talked about much less than other elements of thinking.

Efforts at improving elements of divergent thinking:

1. Conscious and purposeful application of computer equipment can help improve the ***swiftness and lightness of thinking***. The presence of these qualities might be indicated by an abundance of ideas, *working out multiple solutions for a problem, varying and ordering of solutions*.
2. **Flexibility of thinking,** adaptation to changing situations can also be interpreted as approaching the same problem from different points of view. We facilitate the development of this ability by getting to know different models of an IS. These are drawn out in team-work, using the CASE tool



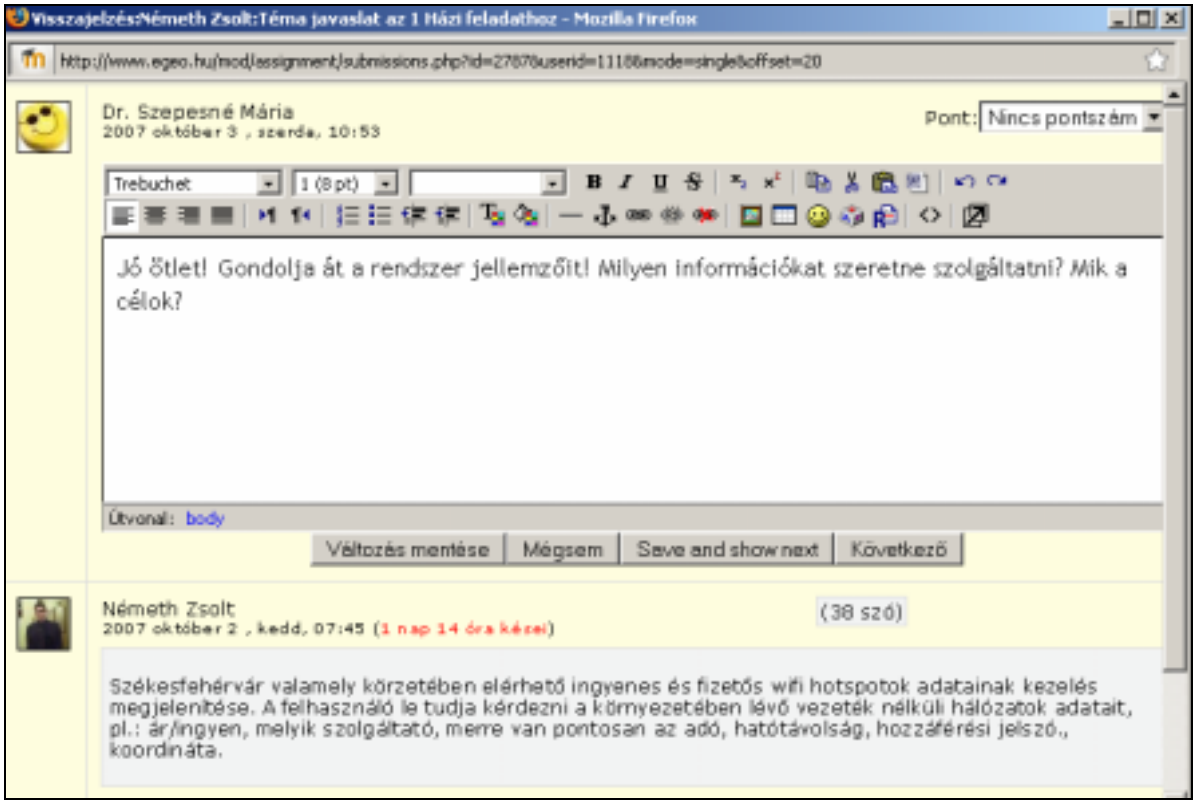
Requirements Model - Object Model – Dynamic Model – Functional Model

Students need to prepare the same models when they work individually on their own projects. This supports the development of their *skills to discover knowledge in different contexts*.

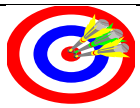
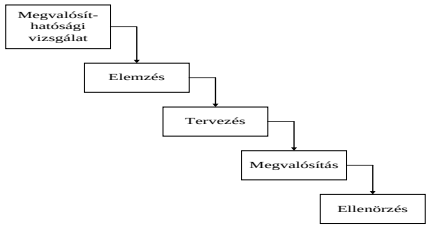
3. **Originality** can be measured with distant associations, exceptional ideas. Individual tasks have a high potential for originality. The need for detailed documentation of the tasks promotes the sharing of original, unique and individual thoughts, while analyzing the documentation gives the lecturer a chance to bring attention to the importance of these skills.
4. **Sensibility** to recognise and define problems can be improved by *promoting students' autonomy*. The topic of individual projects is chosen by the students themselves, limited only by solvability. The students sum up the idea in a few written sentences. This in turn is analysed by the lecturer, who also checks it for originality, than he/she can either accept the project, propose changes to it, or ask for a new project. Student and lecturer communicate with each other through the educational portal, as the table below shows. Of course, personal meetings can also be arranged, especially if there's a difference of opinion between student and lecturer, or if the student requires so. Forums can also be created, to facilitate group-work.

Project task proposal: Please sum up briefly (3-4 sentences) your idea of an information system that you will be working on during the semester

Answer:



We try to sustain the tension and motivation that the problem to be solved induces, by sectioning the project task. This way, we can expect threefold articulation of each part-task, as seen below:

defining the goal	
elaborating and detailed documentation of the solution process	
defining and documentation of the results, the end product.	

5. This requirement also develops the **skill of elaboration**, which shows how much the individual is able to elaborate an idea he or she has. *It means an effort to achieve a complex solution to the problem.*
6. **The ability to rephrase** is improved by exercising different ways of interpretation of knowledge. Description and planning of information systems is done through different models, but always with an object-oriented approach, following RUP (Rational Unified Process), and examining problems from different points of view.

Requirements Model	Requirements the system has to meet. What will it be used for (functional requirements), and what other requirements it needs to meet (non-functional requirements) Usage chart, scenario, user interface
Static model	Elements of the system and their connections. Class diagram, with all of the objects and connections. (Objects menu)
Dynamic model	Dynamic Model defines system control. It defines the order of operations, regardless of what those do, what do they influence and how. Sequential and co-operational chart diagram.

Functional model	Functional model only describes what the system does, but not how and when it does it. Activity-, and data-flow chart

Improvement of the above skills is also promoted by the life-cycle model we follow (incremental/iterative) It requires the re-thinking and re-analyzing of both the problem and the IS. After analysis, modifications are made to the closing task, according to the Requirement Model.

Connection of IS models. Compiling the plan.	Evaluation of the project, feedback, comparative analysis of the Requirement Model and the models serving as plans for the IS.

When developing a **creative personality** there are some *general factors* to be emphasised (self control, preciseness, discipline, self-confidence, bravery, independence, impulsiveness, critical-mindedness, playfulness, sense of humour, tolerance), as well as some *motivational factors* (interest, curiosity, sense of purpose and duty, willpower, perseverance, ambition).

Some of the tools we can use to promote motivation:

*diversity **of questions*** Questions can have a role in inspiring ideas of the solution. Questions that raise problems are usually like this. A question can point straight to the core of a problem situation, or show the contradiction between older knowledge, and a new procedure needed to resolve a new task. Thus they stimulate an active search after solution. Questions can shed new light on a goal. They make us feel we are presented something new and unusual. They motivate us emotionally, giving us a tension that urges active search for the ways of solution. The sense of longing and lack (for knowledge and answers) that a question raises is resolved when the problem is solved; giving a pleasant feeling of satisfaction that accompanies effective problem-solving. Questions can also aim at modifications for easier solution of a task, they can ask for a proposal of solution, they can communicate criticism, or raise doubts.

- *diversity* of ***tasks*** (analysis of these could be the subject of a separate paper)
- ***methods for the evaluation of students achievement***
  (In our case, evaluation is supplemented by the interactive support of the educational portal. Students get constant feedback on their progress, and have the means for self-checking, which in turn increases the effectiveness of their work. The last task can give a chance to make up for earlier faults or deficiencies. Evaluation of the project is done by sharing individual projects, on a group evaluation session.
  In our experience the bonus question has a high motivational value. This gives an opportunity to elaborate on the navigational chart and user interface of the IS. Apart from demonstrating skills in creative thinking, this gives a chance to show some aesthetic creativity, too.

The creative product Creativity turns into innovation at the moment when creative thinking gives birth to a product. The product can be an idea (documented), a task, a whole plan or parts of it, or an actual product.

"Everyone knows certain things can not be accomplished, right until there comes someone who doesn't know about this and accomplishes them" Albert Einstein

The notion, the idea is thus translated into a useful product applicable in daily life. Planning is a creative activity that adds great value to innovation..

„Innovation is process burn out of a creative idea, that will later realise the idea it is burn out of." (Schumpeter, 1910).

While designing information systems we take care to develop written, oral and digital communication skills, too. These skills are required when gathering data, when preparing projects, and writing evaluation papers. Presentation of a project involves oral skills as well.

Implementation and testing of systems. System follow-up.	Logical and aesthetic analysis of the project plan and user interface.
Presentation of completed information system.	Presentation and evaluation of the project

Creativity and innovation are not just a way of thinking, but a general approach that helps one to keep renewing their knowledge and apply it creatively to different professional fields.

SUMMARY

European Year of Creativity and Innovation is a comprehensive initiative spanning many sectors including but not limited to teaching and training, culture, enterprise-development, cohesion politics, rural development, R&D, creative industry (including architecture), audiovisual sector, and information society.
I tried to demonstrate possibilities in education to promote the following features of this European initiative:
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- maintaining and strengthening creative forms of self-expression in adulthood,
- usage of information and communication technologies as a medium for creative self-expression,
- an example for technical sciences developing an active, innovative way of thinking,

- promoting wide-spread understanding of innovative processes, to keep up an entrepreneurial spirit and attitude which helps maintain wealth.

To attain these goals it is necessary to recognise some factors that promote the development of creativity and innovation. These are:

- An **environment** (scientific, social, entrepreneurial) that favours innovation and adaptation.
- And **openness** to cultural diversity. Co-operation between arts, cultures, educational institutions, and openness to change.

It is a task of high priority in education to highlight the important role that creativity, innovation, and entrepreneurial spirit play in personal development, economic growth, and employment.
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