Motivating students in creative technologies educations: PBL and Gamification

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Motivation

Motivation, for students, is the drive or desire to engage in and persist with academic activities and learning tasks.

Types of motivation

Extrinsic Motivation: Extrinsic motivation arises from external factors such as rewards, recognition, or avoiding punishment.

Intrinsic Motivation: This type of motivation comes from within. It is driven by personal interest, curiosity, and the enjoyment of the activity itself.

Creative technologies

Creative technologies education encompasses a broad interdisciplinary and transdisciplinary field that combines computer technology, design, art, and the humanities.

Motivation in creative technologies educations

Motivation plays a crucial role in creative technologies education, just as it does in other fields.
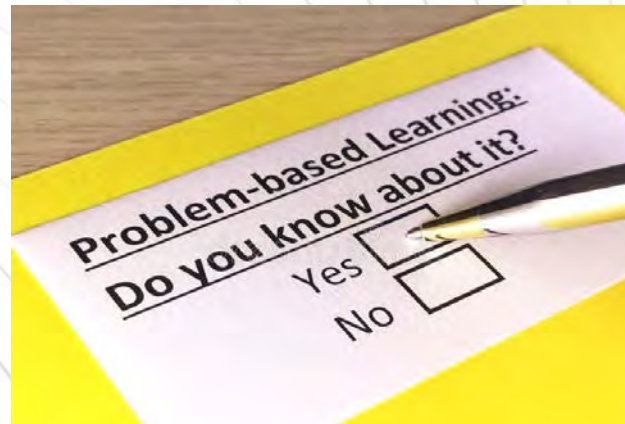
However, there are specific reasons **why motivation is particularly important in creative technology studies**:

- Complex Problem-Solving
- Interdisciplinary Learning
- Rapidly Evolving Field
- Collaborative Nature of Projects

But how?

PBL

Gamification

AAU LEARNING MODEL: PBL

The AAU approach: synergy

Degree programmes based on the educational model Problem-Based Learning (PBL)

RESEARCH

AAU

EDUCATION

INNOVATION
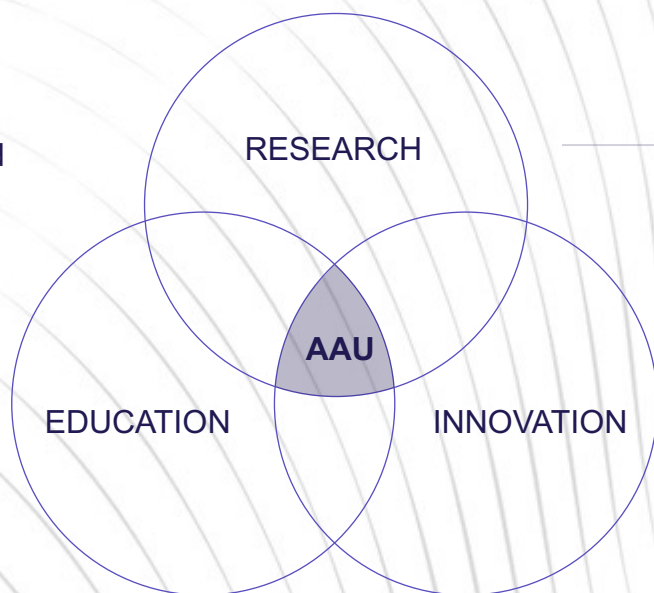
Developing new knowledge of relevance to the challenges of society

Developing new solutions across disciplines – and as co-creation between students, researchers and the wider world

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A bit of history and international context

A number of PBL universities and educations started to emerge in the 60-70's

- Maastricht University, The Netherlands
- Linköping University, Sweden
- McMaster University, Canada
- Newcastle University, Australia
- Roskilde University, Denmark (1972)
- Aalborg University, Denmark (1974)

PBL – No project

PBL & Project

Particularly the McMaster University became an inspiration in relation to PBL in medical education

Similar thoughts among the universities, although uncertainty about the relations / inspirations

A particular Danish approach started to emerge in the 70s – combining problem and project based learning – was related to the social and cultural changes at that time

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PBL at AAU

- Applied since AAU's establishment in 1974

- Students' active role in the acquisition and creation of knowledge

- Redefinition of the role of the teacher in the learning process

- **A problem as starting point of learning**

PBL at AAU

Aims:

- Skills development along with knowledge

- Critical Thinking, Innovation and Creativity embedded in education

- Building networks

- Employability

PBL can have an important role in achieving these!

The AAU model: Problem and Project based learning

- Knowledge and learning is created by the students – not given to the students

- Students are encouraged to solve a problem – they learn through problem solving

- Students complete a project in group

- Students have an academic supervisor who assists them in the project process, challenges and discusses their ideas, and provides feedback on their project work

- Students document their work in a project report which is the subject of an oral (group) examination

The PBL process
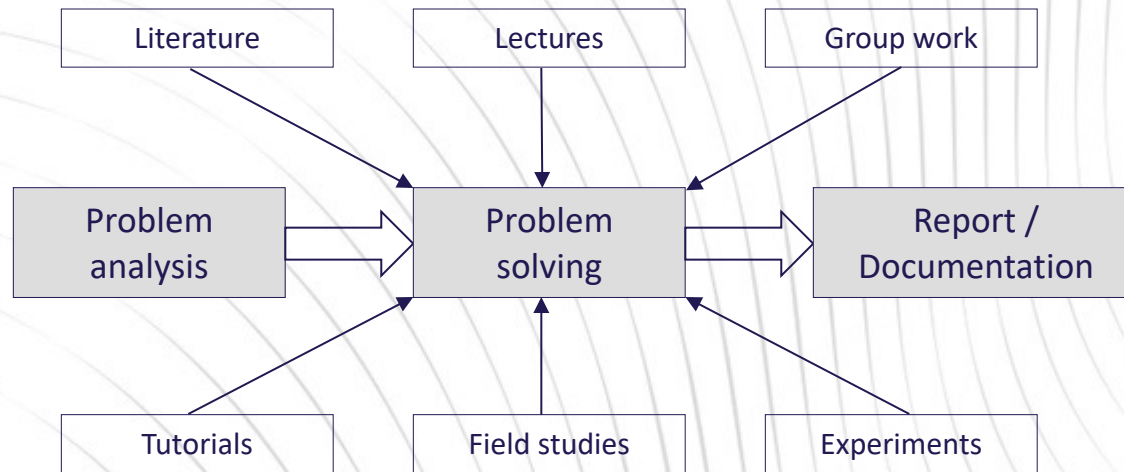
Model from The Aalborg PBL model - Progress, Diversity and Challenges
Anette Kolmos, Flemming K. Fink & Lone Krogh

The PBL Aalborg model

50% courses

Courses 5 ECTS — Individual assessment

Courses 5 ECTS — Individual assessment

Courses 5 ECTS — Individual assessment

50% project

Project 15 ECTS — Group based project assessment

One semester – half year

1 ECTS (European Credit Transfer System) = 30 working hours
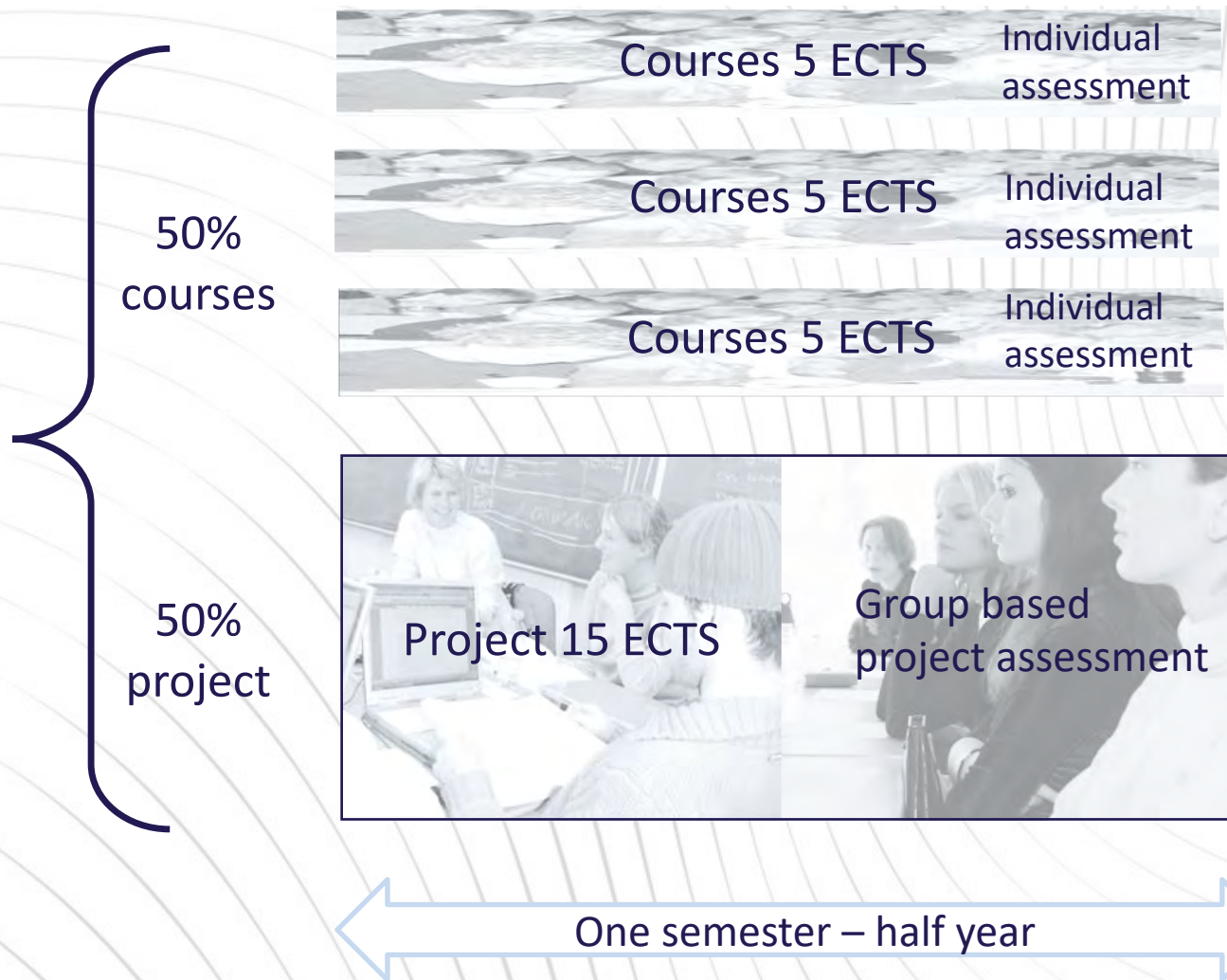
Group Work

Self organized groups

Each project group is allocated working space, typically a group room.

24-hour access.

The PBL learning principles

Learning

Problem based

Cases or Projects

Contextual learning

Social

Participant directed

Team based learning

Content

Interdisciplinary learning

Exemplary learning

Theory-practice relation

Research methodology

Workflow in a typical semester

September-Mid November
- Courses
- Project work

→

Mid November - December
- Project work

→

January
- Course exams
- Project exam

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Project work structure

INTRODUCTION

Getting a grip on the problem area - define the problem area - state how a new approach might be relevant - ends with the **Initial Problem Statement**

ANALYSIS

Description of the problem - target group - a user study - related research/background work - state of the art (related commercial/academic work) - technical possibilities - how to evaluate/test (what methods do others use?) - early prototype test? - ends with the **Final Problem Statement + Design Requirements**

METHODS

What overall strategy will you use to answer the FPS?

DESIGN

Consider different solutions – design a solution

IMPLEMENTATION

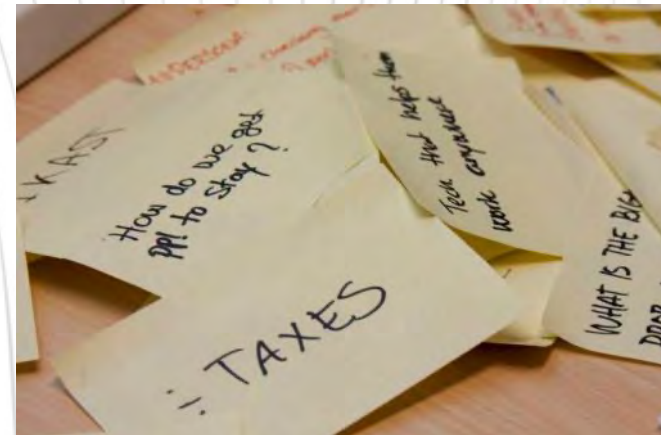Development of the solution – prototyping

EVALUATION

Purpose of the test, test setup, procedure, results, discussion of results

DISCUSSION

Answering the FPS – findings – importance of the work

CONCLUSIONS

Summing up – future directions

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Gamification

Gamification

What is it: the use of game design principles and mechanics in non-game contexts

What brings: making technology more inviting by encouraging users to engage in desired behaviors

Gamification: human nature

Natural human experience

People prefer games over other activities

Growing population of gamers

So many terms

Gamification

Game-based learning

Games

Gameful design

Gameful experience
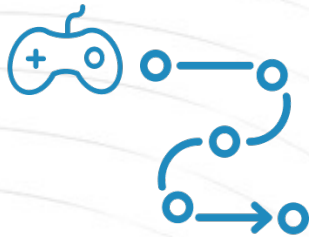
Simulations

Serious games

Playfulness and playful learning

Gamified learning environment

Definitions

GAMIFICATION

The process of applying game design principles and mechanics to non-game contexts, such as education or business, to engage users and encourage desired behaviors.

GAMES
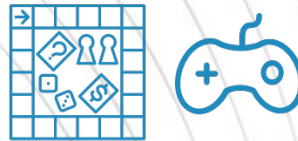
Structured activities with defined rules, goals, and outcomes, typically designed for entertainment or recreation. Games often involve competition, strategy, or cooperation among players. Can be both physical and digital.

SIMULATIONS

Representations of real-world processes or systems, often interactive and computer-based, used for training, experimentation, or prediction. Simulations aim to replicate the behavior of real systems to provide insight or practice in a controlled environment.

Game mechanics

Level

Points

Quest (Challenge)

Badges

Leaderboards

(Zicherman & Cunningham, 2010; Deterding et al., 2011; Bunchball, 2010; Fecher, 2012; Knautz, Wintermeyer, & Goeretz, 2014)

Gamification: intrinsic and extrinsic motivation

Extrinsic motivation is driven by external factors. People engage in a task because of rewards or incentives, even if the task itself isn't inherently pleasurable.

Intrinsic motivation comes from within oneself. When you're intrinsically motivated, you perform an action because it's inherently enjoyable, challenging, or fulfilling.

Effective gamification strikes a balance between intrinsic and extrinsic motivation.

Tangible rewards (extrinsic) can serve as short-term incentives, but the joy of learning itself (intrinsic) remains the ultimate driver.

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Psychological theories

FLOW THEORY

The idea that people are happiest when they are completely absorbed in an activity, experiencing a state of "flow.". Flow happens when the challenge of the task matches your skill level, creating a harmonious and immersive experience.

SELF-DETERMINATION THEORY

Explores why people do the things they do and how their motivation is influenced. It suggests that individuals are more likely to be motivated and satisfied when their basic psychological needs for autonomy, competence, and relatedness are fulfilled. Also introduces the concept of intrinsic and extrinsic motivation.

SOCIAL COMPARISON THEORY

Suggests that people determine their own social and personal worth based on how they stack up against others. In simple terms, we tend to evaluate ourselves by comparing our abilities, opinions, and success to those of others around us. This comparison helps us understand where we stand in various aspects of life and can influence our self-esteem and motivation.

BEHAVIOR REINFORCEMENT THEORY

Is based on the idea that behaviors can be strengthened or weakened through reinforcement. In simple terms, if you reward a behavior, it's more likely to be repeated; if you punish it, it's less likely. Reinforcement can be positive (adding something desirable) or negative (removing something undesirable).

GOAL-SETTING THEORY

Suggests that setting specific and challenging goals can significantly enhance motivation and performance. When people have clear objectives that are a bit of a stretch but still achievable, it can inspire them to work harder and smarter to reach those goals. This theory emphasizes the importance of having well-defined targets to drive motivation and improve overall performance.

EXPECTANCY THEORY

Expectancy theory posits that individuals are motivated when they believe their efforts will lead to good performance and, consequently, valuable rewards. It involves three elements: expectancy, instrumentality, and valence, emphasizing the link between effort, performance, and desired outcomes.

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Flow theory

Flow, also known as being "in the zone," is a mental state where a person performing some activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity

Characteristics:

- **Timelessness**: They lose track of time due to their complete engagement.

- **Intrinsic Reward**: The experience itself becomes rewarding, regardless of external outcomes.
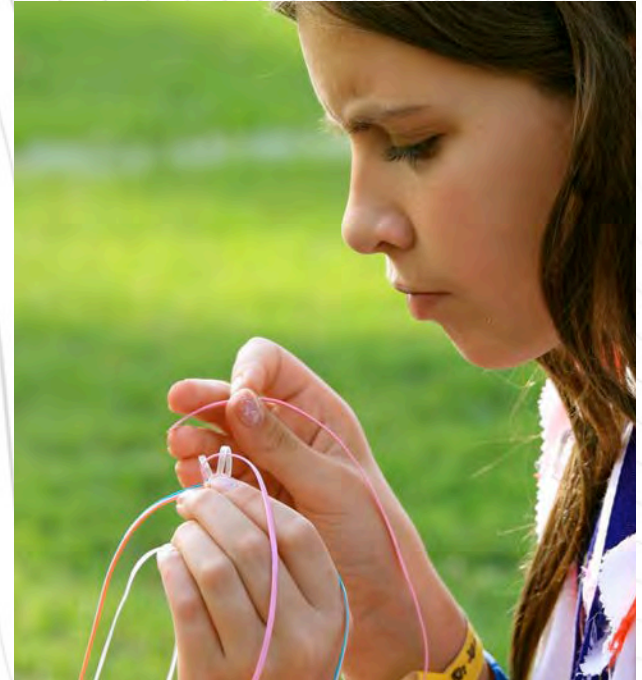
Flow theory and gamification

In gamification, achieving flow is crucial for enhancing engagement and motivation.

Enhanced Engagement: Flow keeps learners motivated and committed.

Optimal Learning: Flow allows users to push their abilities without getting discouraged.

Enjoyment: Learners experience a sense of accomplishment and satisfaction.

Self-Determination Theory (SDT)

Self-Determination Theory (SDT) explains how people's innate psychological needs influence their behavior and well-being

The theory proposes that people have three basic psychological needs: autonomy, competence, and relatedness.

- **Autonomy** refers to the need to feel in control of one's own life and to have the freedom to make one's own choices.

- **Competence** refers to the need to feel capable and effective in one's actions.

- **Relatedness** refers to the need to feel connected to others and to have positive relationships with them.

SDT and gamification

- **Autonomy**: Give players choice and control over their gameplay experience.

- **Competence**: Provide clear goals and feedback that allow players to track their progress and see how they are improving over time.

- **Relatedness**: Create opportunities for players to connect with others, either through co-op gameplay or by providing social features such as leader boards and chat functionality.

Pedagogical theories

ADAPTIVE LEARNING

Adaptive learning is an educational approach that uses technology to tailor instruction and resources to the individual needs and abilities of each learner, providing personalized learning experiences and adjusting content and pace in real-time based on the learner's progress and performance.

POSITIVE BEHAVIOR INTERVENTIONS AND SUPPORT

Positive Behavior Interventions and Supports (PBIS) is a proactive framework used in schools and other settings to promote positive behavior and prevent problem behavior. It involves teaching and reinforcing appropriate behaviors, establishing clear expectations, and providing support systems to help individuals succeed.

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Adaptive learning

- Individualization (take into account the student's prior knowledge, learning style, and pace of learning).

- Real-time feedback (to make necessary adjustments to learning).

- Data-driven decision making.

- Continuous improvement.

Positive Behaviour Interventions and Supports (PBIS)

- All students can learn and succeed.

- Positive behavior should be taught and reinforced.

- Behavior is influenced by the environment.

- Data should be used to inform decision making.

- All stakeholders should be involved in creating a positive school climate.

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Game theories

LUDIC PLAY

The act of engaging in playful activities or experiences that involve elements of fun, enjoyment, and creativity. It emphasizes the idea that playfulness is inherent in human behavior and can be applied to various contexts, not only for entertainment but also to enhance learning.

THE MAGIC CIRCLE

The metaphorical boundary that separates the fictional world of a game from the real world. Within this boundary, players willingly suspend disbelief and accept the rules and norms established by the game. The magic circle serves as a temporary escape from reality, allowing players to immerse themselves fully in the game's narrative and challenges. Can be used by instructor to tackle students skepsis towards games and play.

PLAYER TYPES

Framework by Marczewski used to categorize individuals based on their motivations and preferences in gamified systems. The framework identifies several player types, such as Achievers, Explorers, Socializers, and Killers, each representing different motivations and behaviors in gaming contexts. Understanding these player types can help designers tailor gamification strategies to better engage and motivate users based on their individual preferences.

GAME ELEMENTS AND MECHANICS MODELS

Frameworks used to analyze and understand the components and interactions within games. For example, the MDA model focuses on Mechanics (rules and systems), Dynamics (player actions and behaviors), and Aesthetics (emotional responses and experiences). Other models are the DMC model and the MAT model.

GAME TYPES

There are many different game types and game genres that can inspire the gamification of courses. Some genres/types are: action, RPG, platformer, simulation, sandbox, adventure, survival, sports, puzzle and fighting.

GAME DYNAMICS

Ecompasses what the learners are actually doing in the game. Are they moving a character around the screen? Are they collecting coins for correcly answering questions? Some dynamics include: allocating resources, building, chasing/being chased, collecting, dodging, exploring, matching, problem solving, racing, role playing, stealing, strategizing.

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Other relevant theories

INCREMENTAL DEVELOPMENT

Incremental development is an iterative approach to software development where the product is built and delivered in small, manageable increments or stages, each adding new functionality or features. This method allows for continuous feedback and adaptation, leading to more flexible and responsive development processes.

MINIMUM VIABLE PRODUCT (MVP)

A Minimum Viable Product (MVP) is the most basic version of a product that includes only core features, just enough to satisfy early users and gather feedback for future development.

AGILE

Agile development is an iterative approach to project management that emphasizes collaboration, flexibility, and continuous improvement. Projects are broken down into small chunks, with frequent releases and feedback loops to ensure the final product meets the needs of stakeholders. Unlike traditional methods, Agile embraces change and allows teams to adapt to new information as the project progresses.

DESIGN THINKING

Design thinking is a problem-solving methodology focused on understanding user needs, generating creative ideas, and prototyping solutions iteratively to create innovative and effective products, services, or processes.

SYSTEMIC THINKING

Systemic thinking is an approach to problem-solving and decision-making that considers the interconnectedness and interdependence of various elements within a system. It involves analyzing how different parts of the system influence each other and understanding the system as a whole rather than focusing solely on individual components.

PYTHAGORAS gamification framework
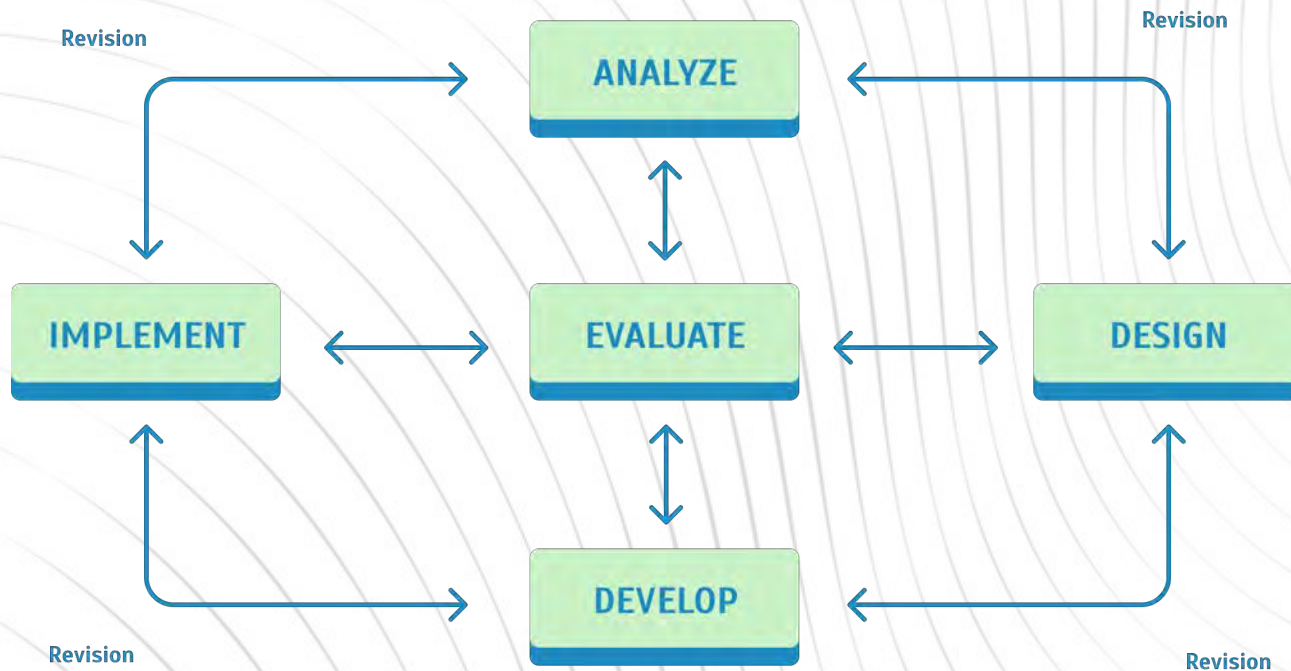
A
ANALYZE

1. Identify Learning Goals
Define Clear Learning Objectives And Outcomes That Align With The Organization's Goals And Learners' Needs.

2. Assess Audience
Understand The Demographics, Preferences, And Existing Knowledge Of The Target Audience.

3. Analyze Content
Breakdown The Subject Matter Into Manageable Chunks And Identify Key Concepts Or Topics For Gamification.

4. Identify Resources
Find Out What Resources You Might Need Access To, Such As Specific Domain Knowledge Or People That Have Domain Knowledge (Art, Gamification, Programming, Etc.), Physical Facilities,Technology And Tools, Etc.

You Should Come Out With

An analysis of training/ learning needs and a learning plan (learning objectives).

D

DESIGN

1. Decide On Structural VS. Content Gamification

Decide Whether To Focus On Structural Gamification Or Content Gamification Based On The Nature Of The Content And Learner Preferences. These Can Also Be Combined.

2. Choose Game Elements And Mechanics

Select Appropriate Game Mechanics And Elements Based On Motivational Needs To Drive Engagement And Motivation.

3. Employ Psychological Theories

Select Appropriate Psychological Theories To Apply Based On Your Audience And Find Out What Elements And Mechanics You Can Match To Apply These Theories.

4. Employ Pedagogical And Instructional Theories

Select Appropriate Pedagogical And Instructional Theories To Apply Based On Your Audience And Find Out What Elements And Mechanics You Can Match To Apply These Theories.

5. Visual Representation

Create A Visual Representation Of The Gamified Learning Experience's Narrative, Interactions, Progression And Other Important Elements. This Does Not Have To Be Good Looking.

You Should Come Out With

An overview of the course design and content sketches.

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DEVELOP

1. Assemble A Team

Depending On The Type Of Gamification You Choose And The Scope Of It, You Need To Assemble An Appropriate Multidisciplinary Team To Develop It. This Might Include Instructional Designers, Game Designers, Subject Matter Experts, Graphic Designers, Software Developers, And User Experience Specialists.

2. Make A Development Plan

Breakdown The Gamified Learning Experience Into Manageable Tasks For Development. This Can Be Done Using Agile/Scrum Development With Short Iterations Iterations (Sprints).

3. Prototype

Create Interactive Mock-Ups Or Prototypes Of The Gamified Learning Experience To Test Its Functionality, Usability, And Engagement. Prototypes Can Range From Simple Sketches To Full Fledged Simulations, Depending On The Stage Of Development And Available Resources.

4. Create Content And Develop

Execute The Plan. Develop The Individual Pieces Of The Learning Materials, Game Assets, And Interactive Elements To Support The Gamified Activities. Start Putting The Pieces Together, This Can Be Done By Using Incremental Development Or MVP.

You Should Come Out With

A development plan, prototypes, and the first version of the gamified course/module.

IMPLEMENT

1. Train The Instructor

Ensure Instructors Are Trained Effectively By Providing Them With The Necessary Skills And Knowledge To Deliver The Instructional Materials.

2. Prepare The Learners

Prepare Learners By Providing Them With The Necessary Resources, Guidance, And Support To Engage Effectively With The Instructional Materials. This Involves Ensuring Learners Understand The Objectives, Expectations, And Available Support Mechanisms, Empowering Them To Actively Participate And Succeed In The Learning Process. The Magic Circle Can Be Used Hear To Put Students In The Right Mindset.

3. Arrange The Learning Space

Arrange The Learning Space Physically To Optimize The Environment For Effective Instruction And Learning. This Includes Organizing The Physical Layout, Seating Arrangements, And Resources To Facilitate Engagement, Interaction, And Comfort Among Learners.

You Should Come Out With

A live course that is working and ready to run.

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E

EVALUATE

These Steps Should Be Repeated Multiple Times Throughout The Process.

1. Formative Evaluation

Collect Ongoing Feedback From Learners And Instructors To Identify Strengths, Weaknesses, And Areas For Improvement.

2. Summative Evaluation

Assess The Effectiveness Of The Gamified Learning Experience In Achieving Its Objectives Through Measures Such As Knowledge Retention, Skill Acquisition, And Behaviour Change.

3. Accessibility And Inclusivity Evaluation

Assess The Accessibility And Inclusivity Of The Gamified Course By Doing Different Evaluations Designed For This.

4. Iterative Improvement

Use Evaluation Data To Refine The Gamified Learning Experience And Enhance Its Effectiveness For Future Iterations Or Implementations.

You Should Come Out With

An evaluation report and actionable changes for the current or future courses.

Player types

Socialisers are motivated by **relatedness**. They want to interact with others and create social connections.

Free spirits are motivated by *autonomy and self-expression*. They want to create and explore.

Achievers are motivated by **mastery**. They are looking to learn new things and improve themselves. They want challenges to overcome.

Philanthropists are motivated by **purpose and meaning**. This group are altruistic, wanting to give to other people and enrich the lives of others in some way with no expectation of reward.

Players are motivated by **rewards**. They will do what is needed of them to collect rewards from a system.

Disruptors are motivated by *change*. In general, they want to disrupt the system, either directly or through other users to force positive or negative change.

Player types

Course Title: "Digital Image Processing: A Gamified course"

Learning Objectives:
Understand fundamental concepts and techniques in image processing.
Apply image processing algorithms to solve real-world problems.
Develop critical thinking and problem-solving skills in the context of image analysis.

Gamification Elements and Design:
Narrative Theme: The course is set in a virtual world where students are apprentice wizards learning the art of image manipulation. Each week, they embark on quests to solve magical image-related challenges and unlock the secrets of the digital realm.
Quests: Students can choose from a selection of quests, each focused on specific image processing topics (e.g., image enhancement, filtering, edge detection). Quests are presented as interactive online modules with clear learning objectives.
XP and Levels: As students complete quests, they earn experience points (XP) and level up their wizard avatars. XP is tied to the difficulty and complexity of the quests.
Badges: Students earn badges for achieving specific milestones or demonstrating proficiency in certain image processing techniques. For example, they can earn a "Master of Image Enhancement" badge for excelling in that area.
Leaderboards: A leaderboard displays the rankings of students based on their XP and badge achievements, fostering healthy competition and motivation.
Social Collaboration: Some quests involve group challenges where students collaborate to solve more complex image processing problems. They can form study groups or teams and earn rewards for teamwork.

Self-Determination Theory Integration:
Autonomy: Students have the freedom to choose their quests, set their learning goals, and explore different areas of image processing based on their interests.
Competence: Quests are designed to gradually increase in complexity, allowing students to build their image processing skills step by step. Immediate feedback helps them gauge their progress.
Relatedness: Collaborative quests promote a sense of relatedness as students work together, share insights, and help each other master image processing techniques.

Flow Theory Integration:
Quests are designed to maintain a balance between the student's skill level and the difficulty of the challenges, ensuring they remain engaged and absorbed in the learning process.
Immediate feedback during quests helps students stay focused and in the flow state.

Agile Process:
Development is organized into iterative sprints, with regular releases of new quests, challenges, and content throughout the course.
Continuous feedback from students is collected and used to refine quest design and improve the overall learning experience.

PBIS Theory Integration:
Students are rewarded with XP, badges, and special in-game items when they exhibit positive behavior such as consistent quest completion, collaboration, and helping peers.
Instructors provide positive reinforcement and recognition for students who excel in image processing challenges.

Adaptive Learning Integration:
An adaptive learning system monitors students' performance in quests and adjusts the difficulty of subsequent quests based on their accuracy and completion time.
If a student struggles with a particular concept, the system provides additional resources, hints, or simpler quests to reinforce understanding.

Assessment and Evaluation:
Regular quizzes and assignments assess students' understanding of image processing concepts and their ability to apply them.
Gamification metrics, such as XP, badge achievements, and leaderboard rankings, are analyzed to assess student engagement and progress.
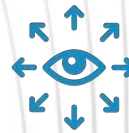
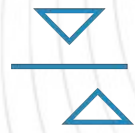# Challenges and barriers to gamification

Lack Of Funding

Time Constrains

Limited Knowledge And Expertise

Stigma And Perception
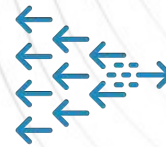
Misalignment With Course Content

Lack Of Guidance And Training

Lack Of Good Examples To Follow

Inflexible Platforms

Resistance To Change

N.B.

- Not everyone is equally enthusiastic about gamification.

- Inclusivity and universal design are important for gamification

- It is not always easy and quick to gamify

- While gamification can enhance learning, it's essential to recognize that learning is complex and cannot be only addressed through gamification.

Thank you

Georgios Triantafyllidis

Tone Eide Hilmen

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