From Curriculum to Gameplay: A Workshop Method for Educational Game Design

Wolfgang Brabänder[1], Ruben Gielisch[1], Polona Caserman[3], Kaja Langer[2], Lisa Scharrer[2] Josef Wiemeyer[2] and Stefan Göbel[1]

[1]Serious Games Research Group, Technical University of Darmstadt, Germany
[2]Institute of Sport Science, Technical University of Darmstadt, Germany
[3]Independent Researcher, affiliated with Research Group Serious Games, Technical University of Darmstadt, Germany

Wolfgang_friedrich.brabaender@tu-darmstadt.de
ruben.gielisch@stud.tu-darmstadt.de
Polona.caserman@tu-darmstadt.de
kaja.langer@tu-darmstadt.de
lisa.scharrer@tu-darmstadt.de
josef.wiemeyer@tu-darmstadt.de
stefan_peter.goebel@tu-darmstadt.de

Abstract: This paper presents a structured workshop methodology for designing educational games to enhance the initial conception phase in game development with educators as a target group. It uses a combination of Björk's game design patterns (Björk et al., 2003) with Andersons's Learning Taxonomy Action Verb Groups (Anderson and Krathwohl, 2001), creating a matrix that connects educational goals with game mechanics. This structured approach is designed to assist educators, who may lack experience in game development, in generating more effective educational game design concepts. The four-step process begins with an introduction and instruction of the method used and continues with the atomization of a learning topic into smaller, specific objectives. This step leaves educators with more manageable learning goals. The third step uses a matrix that maps gameplay patterns and elements from Björk et al. (2003) to Bloom's Taxonomy objectives, identifying appropriate game design patterns. This helps educators see which game design elements support specific learning goals, enabling them to create more engaging educational games. A companion application was developed to simplify this process, allowing participants to browse and filter patterns efficiently, as well as generate random combinations for inspiration. Lastly participants reflect on found gameplay elements to form an educational game design. This Methodology was applied in an ongoing project and the outcomes of the workshop are currently used in the development of the educational game "The Analyst" at the Technical University of Darmstadt. In this project a serious (educational) game is developed to teach the diagnostic process in sport, psychology and pedagogy.

Keywords: Educational games, Serious games, Game design, Workshop, Education

1. Introduction

Serious games have repeatedly proven their effectiveness in supporting their non-entertainment purpose called characterizing goal (Dörner et al., 2016). But they have a massive downside: They are far from trivial in development. To tackle this problem researchers like Horn et al.(2023) developed authoring tools specifically to help teachers and trainers to develop their very own educational games.

Additionally, a lot of frameworks and patterns for the design of Serious Games were created to

tackle the same issue were proposed. A large proportion enables the user to evaluate a game based on various criteria (e.g. Carvalho, et al., 2015) and others are very abstract and simply give rough guidelines to design such a game (e.g. Groff, et al., 2015). The latter usually require some kind of experience in games and game design or are just useful for evaluating a finished game. In those frameworks made to create a game and in tools like GameTULearn (Horn et al., 2023), the initial conceptualization is often neglected, and it is assumed that the author [the educator] starts with an already refined concept of a game.

Therefore, educators must either possess a pre-existing concept and vision for the game they wish to develop, have a comprehensive understanding of game design and its elements, or require structured guidance to get to their educational game idea.

In our collaborations with educators interested in using educational games, we frequently encounter the issue that educators do not know where to begin or what even is possible. This workshop addresses that problem by starting from the very beginning: Educators are guided through the entire process from refining their learning

goals over using a combination of Bloom's taxonomy and Björk's game design patterns(Björk et al., 2003) to address their learning goals to the initial conceptualization of an educational game.

2. Related Work

2.1 Related Frameworks

Many Models and Frameworks exist to assist the creation of (educational) games.

The Mechanics, Dynamics, and Aesthetics (MDA) framework by Hunicke et al.(2004) introduces a foundational view of games but lacks guidance for idea generation. Building on this, the Design, Play, and Experience (DPE) framework by Winn (2009) expands the MDA model to explore the interplay between the developer and the player, emphasizing early definition of learning goals, although it offers limited practical tools for conceptualization. The Art of Serious Game Design (ASGD) framework by Toronto Metropolitan University (2023) advances DPE by incorporating ideation cards and a glossary to streamline brainstorming. While the ability to formulate key questions is a strength, a notable weakness lies in the provision of comprehensive game design and development information, specifically regarding feasible options and established best practices.

The Game Rules Scenario Model (GREM) by Zarraonandia et al. (2015) focuses on modularity and reusability by emphasizing the context of learning, but provides little support for initial conceptualization. Similarly, the Activity Theory-based Model of Serious Games (ATMSG) by Carvalho et al. (2015) categorizes serious games into various activities, but primarily serves as an analytical rather than a creative tool.

The Four-Dimensional Framework (4DF) by De Freitas and Oliver(2006), while offering a reflective tool for evaluating games based on context, learner specification, and pedagogy, does not aid in generating ideas. The Exploratory Learning Game Design Model by De Freitas and Neumann (2009) adapts Kolb's experiential learning theory for complex virtual contexts but remains abstract and impractical for game conceptualization. The Balanced Design Framework by Groff et al.(2015), though extending evidence-centered design principles, remains focused on assessment rather than idea generation. Lastly, the Learning Mechanics-Game Mechanics (LM-GM) by Arnab et al.(2015) which is a powerful model to analyse serious games but is a helpful resource since it too maps gameplay mechanics onto bloom learning taxonomy.

Table 1: Overview of related frameworks

Framework	Authors	Year	Focus	Limitations
MDA	Hunicke et al.	2004	Foundational view of games	Lacks guidance for idea generation
DPE	Winn	2009	Interplay between developer and player, learning goals	Limited practical tools for conceptualization
ASGD	Toronto Metropolitan University	2023 (earlier iterations exist)	Incorporates ideation cards and glossary	Lacks Provision of best practices
GREM	Zarraonandia et al.	2015	Modularity and reusability, context of learning	Little support for initial conceptualization
ATMSG	Carvalho et al.	2015	Categories serious games into activities	Analytical rather than creative tool
4DF	De Freitas and Oliver	2006	Reflective tool for evaluating games	Does not aid in generating ideas
Exploratory Learning Game Design Model	De Freitas and Neumann	2009	Adapts Kolb's experiential learning theory	Abstract and impractical for game conceptualization
Balanced Design Framework	Groff et al.	2015	Extends evidence-centered design principles	Focused on assessment rather than idea generation
LM-GM	Arnab et al.	2015	Maps gameplay mechanics onto bloom learning taxonomy	Helpful resource but not for idea generation

The issue has been addressed multiple times; however, when creating an educational game, it is imperative to involve educators in the creative process of a game designer. The methods and frameworks highlighted aim to provide a structured understanding of what constitutes a game to facilitate the creation of these games. Some efforts focus on mapping educational principles onto gameplay principles, offering a reference system where "if educational outcome A is desired, employ gameplay feature B." These approaches emphasize formalization so that designers proficient in both disciplines can achieve optimal results.

What remains lacking is an ideation phase for educators who are inclined toward utilizing game-based learning approaches and educational games but do not possess the requisite knowledge to design a game. One method addressing this gap is detailed in the Art of Serious Game Design by the Toronto Metropolitan University (2023). The authors developed a workshop wherein educators respond to various questions to generate a repository of ideas. A game designer subsequently uses these ideas to create a game design. However, if an educator wishes to design their own game, it is crucial to develop a method that empowers educators to act as the actual game designers, selecting what best aligns with their classroom needs.

Given that it is unrealistic to expect educators to possess extensive knowledge of all game design principles, a simplified approach is necessary: Game Design Patterns.

2.2 Game Design Patterns

Björk et al. (2003) describe game design patterns as “a part of the interaction possible in games, and together with other patterns they describe the possible gameplay in a game “. These patterns aim to be used for game design and in particular creative design work, so a perfect fit for a method that tries to support the conceptualization phase, one of the most creative phases in this work. The book and the accompanying online Wikipedia[1] contain 633 different game design patterns, each with a name, core definition, general description, how to use it, consequences of using it, relation between patterns and references to it in other patterns.

The core definitions and names can be a great source of inspiration when trying to develop an idea, but 633 patterns can be quite overwhelming. So, we need a way to lead educators to a smaller selection of patterns relevant to their current needs and ideas.

2.3 Taxonomies for Learning

There are numerous taxonomies for learning, but one of the most widely used is the 5-point taxonomy developed by Bloom (1956) and revisited by Anderson and Krathwohl (2001), in which the authors categorize the cognitive process dimension into 6 categories:

Remember, Understand, Apply, Analyse, Evaluate and Create.

Each category also has related Cognitive Processes as seen in Table . These Processes or ’action verbs’ can be used to describe atomic learning objectives.

[1] http://virt10.itu.chalmers.se/index.php/Category:Patterns

Table 2: The Six Categories of the Cognitive Process Dimension and Related Cognitive Processes (Anderson and Krathwohl, 2001)

Process Categories	alternative Names
1. Remember	
1.1 Recognizing	Identifying
1.2 Recalling	Retrieving
2. Understand	
2.1 Interpreting	Clarifying, Paraphrasing, Representing, Translating
2.2 Exemplifying	Illustrating, Instantiating
2.3 Classifying	Categorizing, Subsuming
2.4 Summarizing	Abstracting, Generalizing
2.5 Inferring	Concluding, Extrapolating, Interpolating, Predicting
2.6 Comparing	Contrasting, Mapping, Matching
2.7 Explaining	Constructing, Models
3. Apply	
3.1 Executing	Carrying out
3.2 Implementing	Using
4. Analyze	
4.1 Differentiating	Discriminating, Distinguishing, Focusing, Selecting
4.2 Organizing	Finding, Coherence, Integrating, Outlining, Parsing, Structuring
4.2 Attributing	Deconstructing
5. Evaluate	
5.1 Checking	Coordinating, Detecting, Monitoring, Testing
5.2 Critiquing	Judging
6. Create	
6.1 Generating	Hypothesizing
6.2 Planning	Designing
6.2 Producing	Constructing

3. Workshop Design

Every game starts as an idea. An educator decides to create an educational game based on a curriculum or learning goal. The challenge is to turn this vision into an effective game design.

This workshop has 4 phases: Instruction, Learning Goal Atomizing, Game Design Pattern Exploration, and Game Conceptualization.

Walking through these phases educators can map learning goals they wish to gamify to game design mechanics and patterns which are fitting their goals. The output of the Process is not only a better understanding of what the game could be, but a better communication between educators and game developers.

3.1 Instruction

Instructing the participants to the method used. As we use Anderson's revision of Blooms taxonomy (Anderson and Krathwohl, 2001) for structuring atomic learning goals, a short recap of this taxonomy is explained. All the instructor needs is a poster or 1-2 presentation slides to show the agenda and blooms taxonomy.

The general principles of game design patterns are explained and what the method targets to enable: Communication with game developers and consequently a better game concept.

Participants can use any tool they prefer, including digital and physical whiteboards, pen and paper, notepads, or other tools that assist in capturing their thought process. The chosen tools should be familiar to them and not impede their creativity due to handling difficulties during the workshop.

3.2 Learning Goal Atomization

Educators start this method with the idea of teaching learning content with a game, but this content may vary in size. Many teaching goals can be broken down into smaller goals. So, in this step educators will start to "atomize" their initial learning goal.

Educators break down main goals into smaller sub-goals, forming a tree view (see Figure 1). This continues until sub-goals can no longer be divided. The aim is to create atomic learning goals. Finally, action verbs from

Anderson's learning taxonomy are added as child nodes to each goal, resulting in a tree with action verbs as leaves. For instance, the tree in Figure 1 includes "recall objectivity" as a learning goal with its action verb in the applied pilot of this workshop (see chapter 4).

Educators should decide when to stop breaking down learning goals into smaller parts before they become too small. A tree view is useful for tracking this process, allowing educators to merge overly atomized goals back into larger ones if needed.

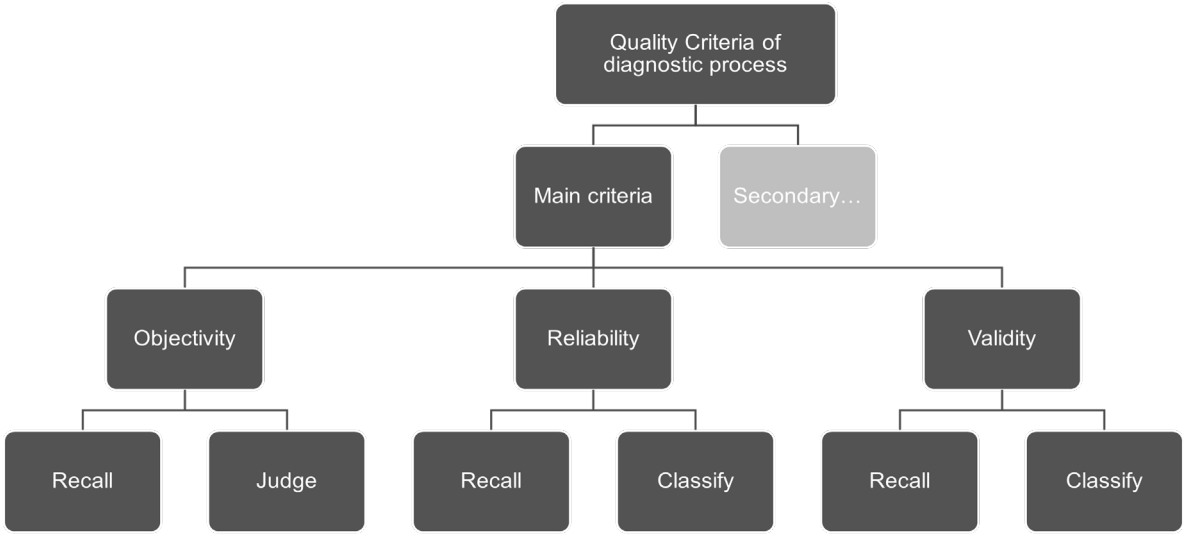

Figure 1: Tree View of a sample learning goal atomization

3.3 Pattern Exploration

Once we have the tree view of the atomizing step, we take all leaves into consideration. In this step we will design game elements based on atomic learning goals by using Björk et al.'s (2003) game design patterns.

We assigned each pattern one or more action verbs relating to Anderson's learning taxonomy while pruning Björk et al.'s patterns in a way, that we combined very similar pattern into one.

The mapping of pattern onto action verbs creates a look-up table for participants. This method allows educators to substitute for any lack of game design knowledge and boosts creativity. With action verbs assigned in step 2, educators can now find suitable game elements and patterns for their learning goals.

To enhance this process, we implemented a companion app (see Figure 2) in which one can choose an action verb an only browse patterns that have this action verb assigned. The workflow would be to choose an action verb on the left of the app and get three sample patterns fitting for this action verb. Participants can now take a closer look at one of the patterns (see Figure 3), request three alternative patterns if the shown patterns do not meet their needs or select a suitable pattern and proceed to the next learning goal.

Via this browsing process educators get already ideas of what is possible and has potential to benefit the learning goal.

For each leaf (from the learning goal atomization) a pattern can now be chosen, while by no means for everything another distinct pattern must be chosen. It can absolutely be beneficial to have the same pattern for many learning goals. This way a more compact and coherent game design can be made.

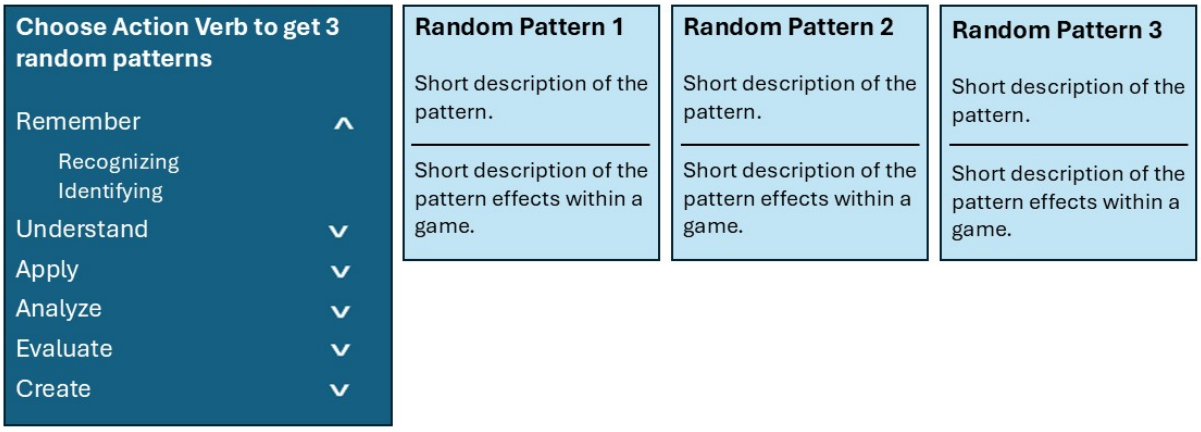

Figure 2: Simplified view of the companion app. Left: overview of alle Action Verbs. Right: Short description of sample Patterns in the chosen Action Verb Group

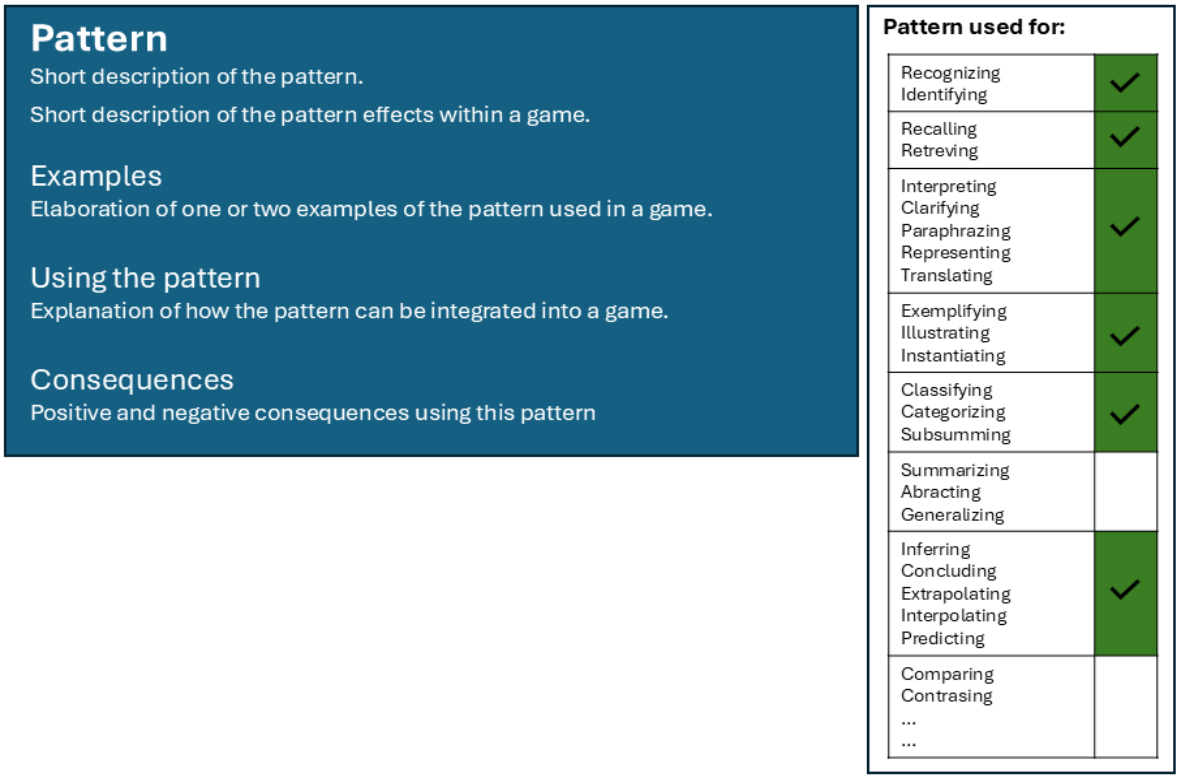

Figure 3:Simplified view of the companion app with detailed view of a pattern. Left: detailed explanation of the pattern.(Björk et al., 2003) Right: Action Verbs fitting for this pattern

3.4 Game Design and Reflection

At this stage, each atomic learning goal is assigned a game design pattern. If all leaves of a parent node have the same pattern, one can assign this pattern to the parent node and remove the leaves to simplify the process.

Next, the actual game design begins. Educators can define, visualize, etc., their ideas regarding game content, player actions, and narrative challenges.

This step is characterized by its flexibility and potential for creativity. The aim is to produce an output that enables a game developer to create a game design and development plan aligned with the educators' vision.

Figure 4 illustrates the difference in outputs between two groups following the creative phase. Each group gained a clearer understanding of their game concepts and effectively presented their ideas to peers and the authors (see Chapter 4: Pilot Workshop).

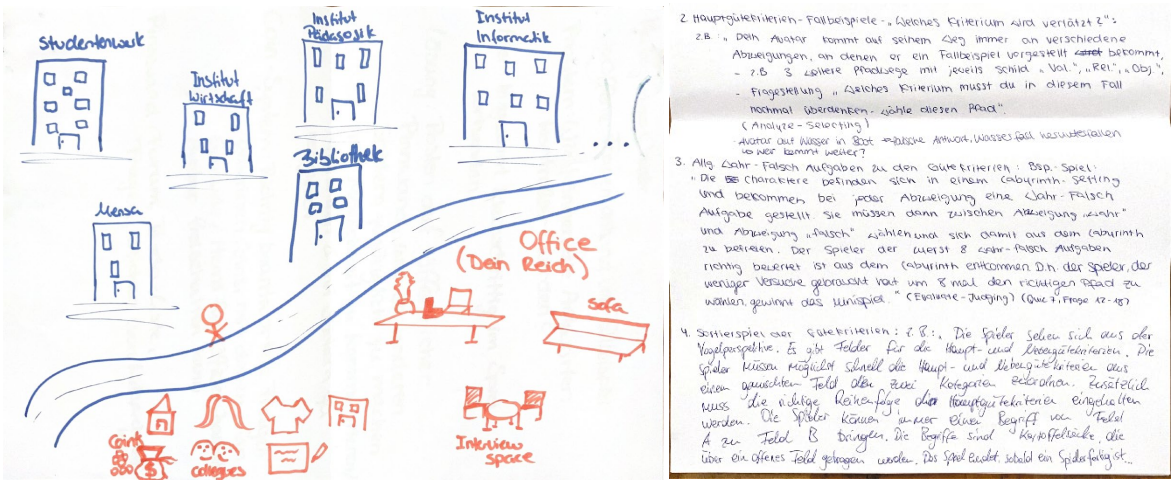

Figure 4: Output styles of 2 different groups after the workshop, see chapter 4

4. Pilot Workshop

In the project “The Analyst” funded by “Stiftung Innovation in der Hochschullehre” this method is utilized to lead students through the process of developing game design concepts for an educational game aimed at diagnostics in sports sciences. This approach resulted in a variety of gameplay mechanics now used in the further development of the game.

The goal to use the proposed method in this project was to not only generate ideas in a participative way, but to see if the creativity from the participants would benefit from this approach.

The workshop was held with overall 40 students at the technical University of Darmstadt at three different times and let them assign themselves into groups of 2-4 students. As the students would take on the role of an educator in this scenario they got access to learning materials prior to the workshop day. From the given-out materials they were told they can choose one topic which will be relevant to them during the workshop.

Participants were initially briefed on the method ("Instruction") and introduced to the project where their ideas would be used in.

After that they had 2 hours for the next steps up to the presentation of their results. This way each group could time their own process accordingly to their speed. We didn’t have to limit their time on learning goal atomization or pattern exploration.

We (the authors) were present during the workshop for further (re-)explanation, guiding through the process or explaining the game design patterns found by the companion app.

After the two hours all participants returned and presented their results in front of all other participants.

During the workshop participants were allowed to choose to go to another room and had the ability to choose to use paper, whiteboards or online tools to write down their process and results.

After the workshop participants could rate their overall experience during the workshop on a 5-point Likert scale ranging from very poor to very good and had the chance to give freeform feedback. This feedback was given as explicit positive or negative feedback.

4.1 Analysis of the Feedback

As seen in Figure 5, 37 of the 40 participants rated the method as either good or very good ending in a mean (counting very good as 4 and very poor as 0) overall experience of 3.25. This reflects our impression during the workshop as all participants were concentrated and eager to exchange with their peers.

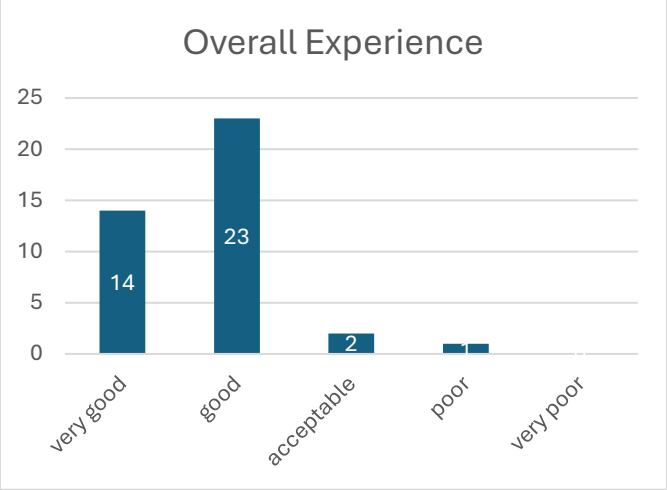

Figure 5: Overall Experience of Participants

Using the method and tools developed by Arlinghaus et al.(2024) we combined both positive and negative feedback statements and started to categorize these inductive into categories. The output categories from the tool provided by Arlinghaus et al. were pruned in a way that we erased duplicates and merged categories too similar to another into one.

We also erased all statements that either are just general feedback like the answer “Nothing” for the negative Feedback and all statements that are in no regard to the workshop itself like the overall positive feedback on edibles we had prepared for all participants (apples and pretzels).

After that step, eight categories were left, and all statements were assigned to at least one category.

The categories are:

1. Creativity and Freedom: Everything related to the creative process
2. Group Work and Interaction: How the peers interacted with each other
3. Atmosphere and Environment: Everything related to the feeling of the environment the workshop was held in
4. Learning and Knowledge Application: Here the statements are clustered that relate to the idea of educational games per se.
5. Motivation and engagement: How motivated the participants were or became during the workshop
6. Time Management: everything timing related
7. Clarity of Instructions and Guidance: If the instructions were clear and the guiding through the workshop was sufficient
8. Preparation and Materials: Given the nature that we had students take the role of an educator, they had preparation time and materials given out prior to the workshop

Every statement that fits into more than one category was split into smaller statements, so each statement was assigned to exactly one category.

In Table 3 Freeform categorization overview we show an overview of the categorized statements sorted by the overall number of statements in each category.

Table 3: Freeform categorization overview

Category	Positive Statements	Negative Statements	positive %	negative %	#statements
Creativity and Freedom	19	1	95,00%	5,00%	20
Group Work and Interaction	14	6	70,00%	30,00%	20
Clarity of Instructions and Guidance	3	12	20,00%	80,00%	15
Atmosphere and Environment	10	3	76,92%	23,08%	13

Category	Positive Statements	Negative Statements	positive %	negative %	#statements
Learning and Knowledge Application	9	2	81,82%	18,18%	11
Time Management	3	6	33,33%	66,67%	9
Motivation and Engagement	7	0	100,00%	0,00%	7
Preparation and Materials	1	6	14,29%	85,71%	7

For our method the most valuable categories are “Creativity and Freedom”, “Clarity of Instructions and Guidance” and “Motivation and Engagement” since these are the primary points we tried to tackle with the method.

Overwhelmingly positive are the two categories “Creativity and Freedom” and “Motivation and Engagement”.

In the Creativity and Freedom Category the statements were mostly very short and just stated, that they liked the freedom they got and that they could use all their creativity they had. Some more detailed statements were: “I liked: The creative approach to the task stimulates creative thinking and continuous improvement processes for your own ideas“ and “I liked: You had a lot of freedom to come up with (creative) things and didn't have many restrictions “.

The only negative statement was ironically the same many others stated in the positive feedback: “The freedom”.

With 19 positive statements and one negative, the method clearly achieves its goal by enhancing creativity and freedom.

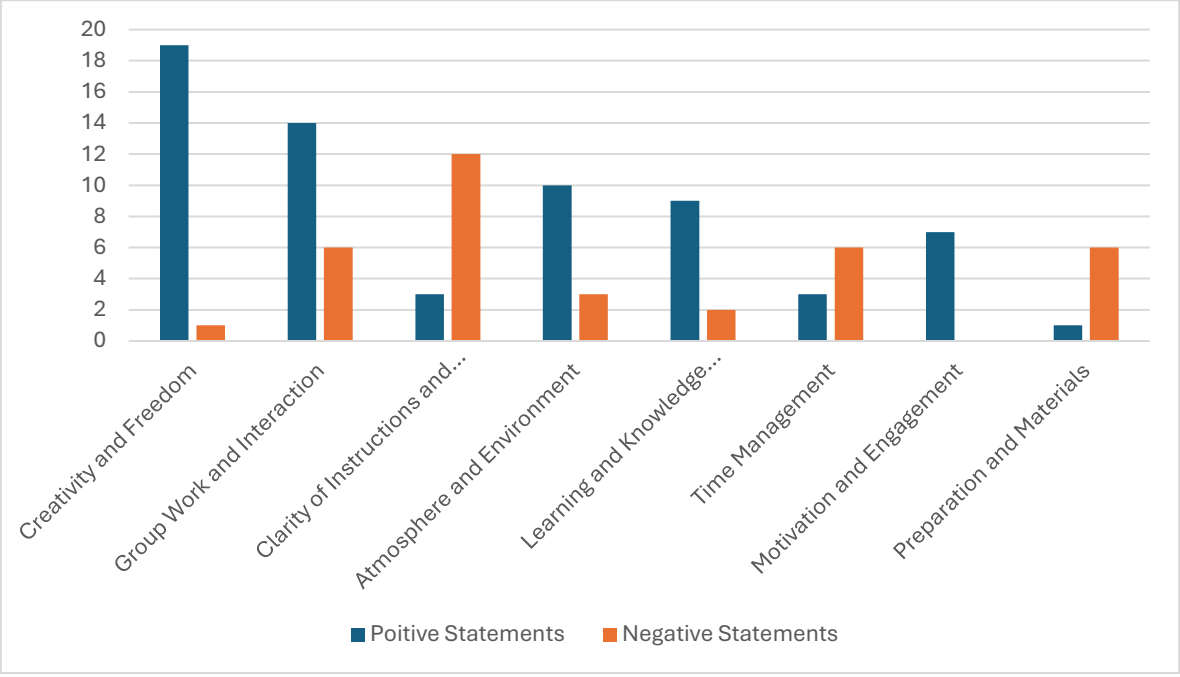

Figure 6: Breakdown of the positive and negative statements sorted (left to right) by the total amount of statements in the corresponding category

The category “Motivation and Engagement” had less statements overall but only positives. Mainly the statements were about that the project itself and game-based learning as an approach was motivating to brainstorm ideas. The fact that the participants were students assigned to develop ideas for an educational game that could be used later for their own courses was motivating too. Overall, this category was heavily influenced by the fact that the participants were students, so this category is not meaningful with the target group of teachers.

The third of the most valuable categories “Clarity of Instructions and Guidance” had mainly negative feedback with 7 negative statements and only 3 positive statements. So here it is essential to review the detailed statements to improve the workshop.

The main negative point was that the task given wasn’t clear to all participants. Some wish to have a more narrowed down task like at least a game genre or a demonstration of a prototype their ideas would be integrated to have better starting point.

Examples of these statements are:

> *“It wasn't clear to me at the beginning what the exact procedure should be. The invitation to work creatively should have been more prominent in the introduction. “*
>
> *“What could be improved: the game idea could have been explained better or what computer games look like and what is possible here could have been explained better. not all of us are gamers. „*
>
> *“I didn't like it very much: Unfortunately, it was a bit difficult at the beginning to come up with a topic or a concrete approach. It might help to limit the task for the groups a little or to be more specific. “*

On the other hand, the positive statements mentioned availability during the workshop, so we had the possibility to guide them through the process.

The main takeaway from this category is that the initial instructions should be clearer and a brief introduction to (serious) games would be helpful to tackle the negative statements, but the guiding through the workshop was perceived positive.

In the category Management and Preparation, the most common statement was that time was limited. While participants had insufficient time, this also indicates their desire for more time to work on their game concepts, which can be seen as a positive aspect.

5. Limitations

While the workshops provided valuable insights, some limitations should be considered. One potential challenge is the differing levels of familiarity among educators with foundational concepts like Bloom's taxonomy. This workshop currently expects participants to have at least a basic understanding of Bloom's taxonomy, or to acquire this understanding at the start of the workshop. As indicated in Figure 6, the preparation and materials were annotated accordingly, suggesting that the taxonomy could be included in the preparation or distributed during or before the workshop.

Additionally, narrative and aesthetic considerations in game design were not explicitly addressed during the workshops. These elements are crucial for fostering engagement and ensuring the seamless integration of educational content into game-based learning environments. Although this workshop emphasizes gameplay mechanics, future initiatives may explore these aspects further to assist participants in balancing the functional and experiential dimensions of their designs.

6. Future Work

Currently we’re working to enhance the given game design patterns and develop more specific educational game design patterns which are targeted on educators, so they [the educators] can intuitively understand the pattern and the possibilities those patterns have. These educational game design patterns will become the primary patterns to explore during the exploration phase with the game design patterns by Björk et al. (2003) remaining a fallback and additional resource for educators.

The results from the reflection phase of the performed workshops are currently undergoing a deep screening and are involved in further development of the game “The Analyst”.

Acknowledgements

This research has been funded during the Project “The Analyst” funded by “Stiftung Innovation in der Hochschullehre”.

Disclosure of Interests: The authors have no competing interests to declare that are relevant to the content of this article.

Ethics declaration: No ethical clearance was required for the research of this paper.

AI declaration: AI has been used in two cases in the development of this paper: As the authors of this paper are not native English speakers, Microsoft Copilot has been used to rephrase chosen sentences for a better understanding. As stated in Chapter 4, an LLM[2] has been used in the process of inductive categorization of the free form statements of the probands. (Arlinghaus et al., 2024)

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