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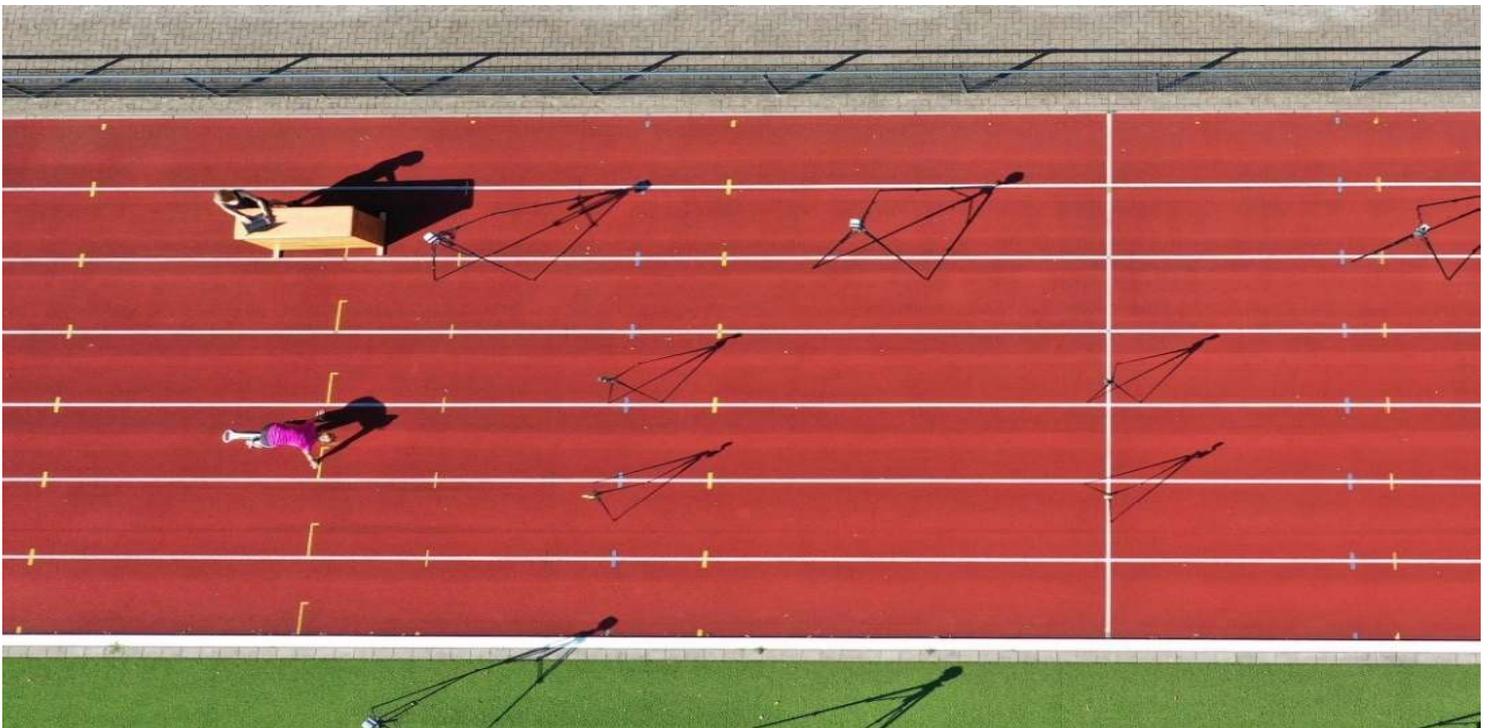
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Arbeitskreis 2 "Spielanalyse & Methoden"

„The Analyst" – Serious Game als Lerndiagnostik (Kaja Langer, Lisa Scharrer, Polona Caserman, Wolfgang Brabänder, Christian Hoppe, Stefan Göbel & Josef Wiemeyer)

Enhancing Neurophysiological Research: An Automated Method for Measuring Cortical and Ipsilateral Silent Period Latencies with Precision – An Intermethod Reliability Study (Teni Steingräber, Michel Klemm, Jan Straub, Saskia Kurtzhals, Lea Sasse, & Jitka Veldema)

„The Analyst" – Serious Game as Learning Diagnostics

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Introduction

Serious games are a special type of computer games that have to fulfil a double mission: „A serious game is a digital game created with the intention to entertain and to achieve at least one additional goal (e.g., learning or health)" (Dörner et al., 2016, S.3). This double mission is characterized by the terms "attractiveness" and "effectiveness", which shall lead to a "dual flow" (Fig. 1).
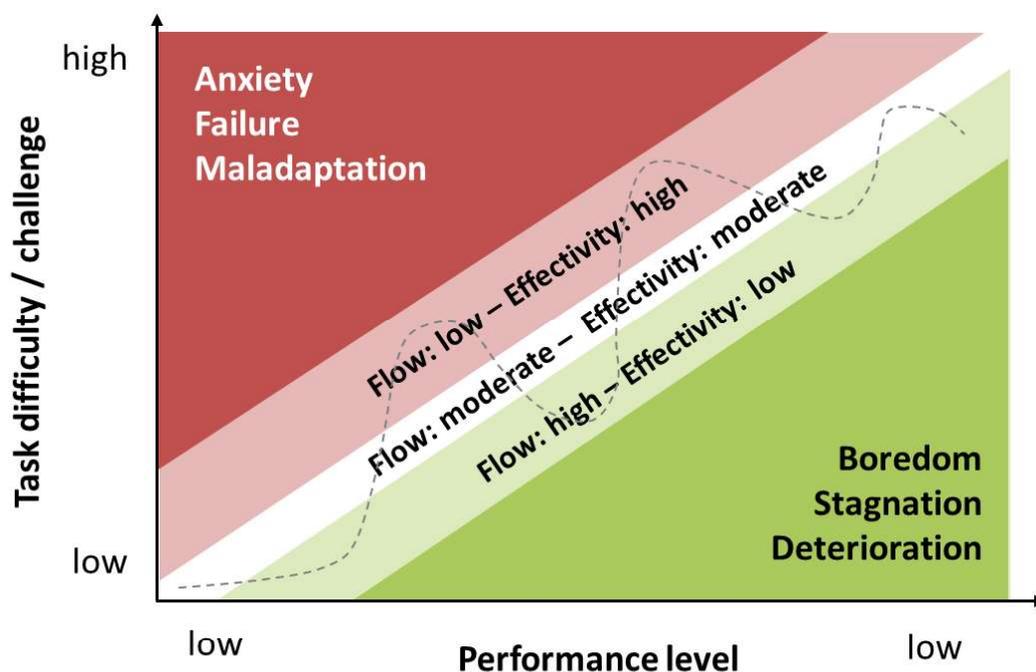

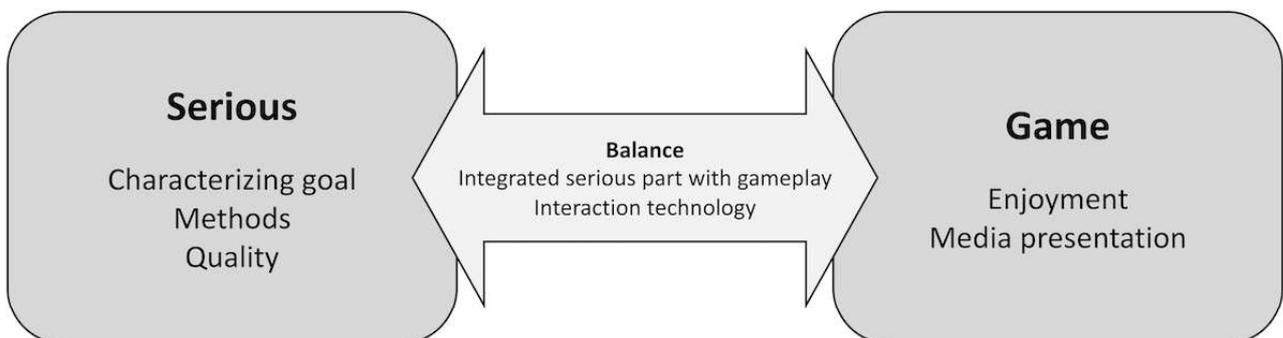*Fig. 1.* Dual Flow – between effectiveness and attractiveness (Wiemeyer, 2024, p.210).

Fig. 2. Serious games – Balance between effectiveness (Serious part) and attractiveness (Game part; Caserman et al., 2020, p.4).

The appropriate balance between attractiveness and effectiveness is decisive for the effect of serious games (Fig. 2).

Neither serious goals (e.g., learning and health effects) nor game goals (e.g., fun, game flow and entertainment) should be dominant.

Therefore, the applied learning and play measures have to be equally coordinated.

In the current research project[1] a Serious Game addressing the topic "diagnostics in human sciences" will be developed. In the learning game "The Analyst" players can experience a variety of diagnostic use cases in the human sciences (pedagogy, psychology and sports science) themselves and receive differentiated and motivating learning-related feedback. The game is developed by an interdisciplinary team (Human Sciences, Computer Science/serious games and University Didactics). On the basis of player-centred design, the students are systematically involved in the game development (surveys, design, own development contributions, evaluations).

In this article, the basic concept, the contents, methods, and diagnostics are presented.

Basic concept

In the serious game "The Analyst" the students shall playfully improve their competencies in diagnostics of human sciences. In the game they can access various elements (knowledge, quiz, and videos; Fig. 3) and receive continuous interactive and motivating feedback as a key factor in the success of learning games (e.g., Ravyse et al., 2017). All playing activities will be stored to enable teachers to analyse them.
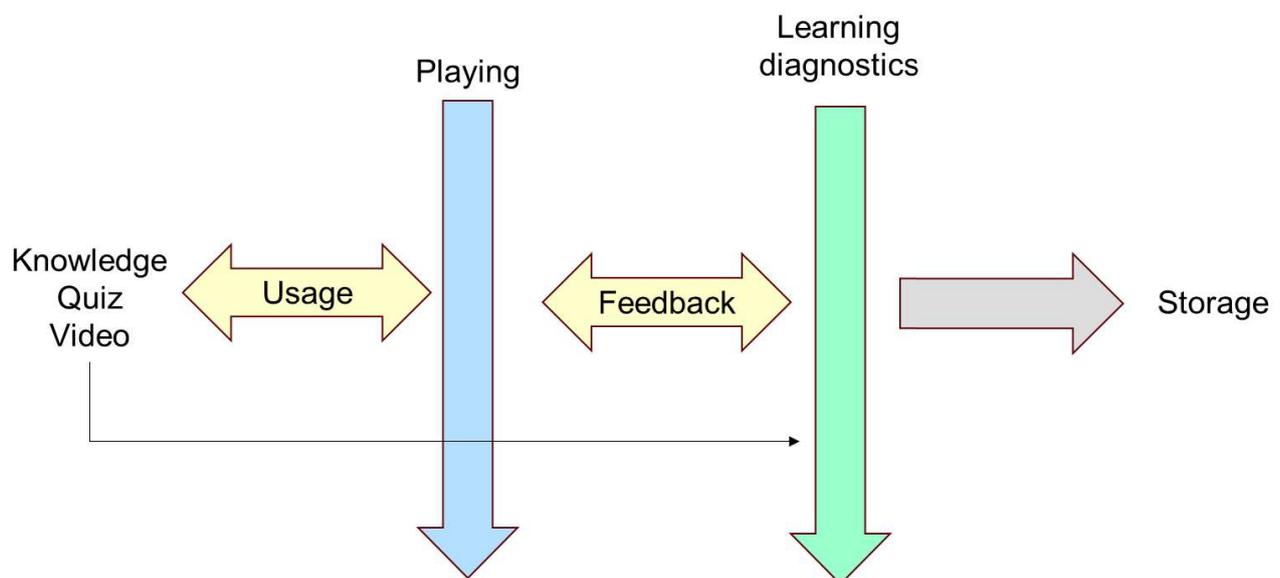

Fig. 3. Game concept as an interaction of playing, usage of knowledge, quiz, and video as well as feedback.

Content and game elements

The game content includes diagnostic basics and principles (concepts for planning and development, quality criteria, diagnostic procedures) and concrete diagnostic applications (e.g., Bös, 2017; Ingenkamp & Lissmann, 2006; Schmidt-Atzert et al., 2021).

In addition to knowledge elements (slides, text, teaching recordings), the game contains quizzes and various video formats. Concrete diagnostic applications are developed as real videos and 3D animations based on motion capture.

The quiz tasks address four competence levels: reproduction, reflection, application, and evaluation of diagnostics in human sciences. Three levels of difficulty are distinguished: basic, medium, and excellent. The feedback contains four elements: content-related feedback and three elements supporting motivation (see Tab. 1).

Tab. 1. *Feedback elements.*

Short motivation	Feedback regarding level of solution	Constructive continuation
Super!	You have chosen the correct answer.	Keep up the good work.
Good work!	You have solved the task partially correct.	Check the details once again.
Stay tuned!	Unfortunately, your answer was not correct.	Try it once again.

The videos contain digital low-poly avatars, which were generated from motion-capture data, and real videos (Fig. 4).

Fig. 4. Video formats in the game: Left: Low-poly Figure; Right: Real videos

The game narrative is a scientific internship in an institute of diagnostics that has to be performed as part of a study programme. The player enters the institute and is welcomed and instructed by the chief of the institute. Afterwards, a mentoring person will accompany the player through the game.

Game elements are key factors influencing "player experience", e.g., competition, rewards, fun, and GameFlow (Wiemeyer, et al., 2016). Abeele et al. (2020) could prove that "player experience" contains functional and psychosocial components that correlate significantly with gaming fun (Tab. 2).

Tab. 2. *Components of "player experience" according to Abeele et al. (2020).*

Functional elements	Psychosocial elements
Ease of control	Mastery
Process feedback	Curiosity
Audiovisual appeal	Immersion
Goals and rules	Autonomy
Challenge	Meaning

These components are also addressed in numerous development and evaluation models as well as studies and reviews (e.g., Ang & Rao, 2008; Caserman et al., 2020; Lyons, 2015; Mao et al., 2024; Pfannstiel et al., 2009; Ravyse et al., 2017; Yannakakis & Hallam, 2009). Among others, the following measures are suggested:

- Attractive, consistent narratives and storylines
- Variable, stepwise increasing difficulty levels
- Diverse, clearly defined and subjectively meaningful goals and target levels
- Frequent, clear, constructive and encouraging feedback on status and progress, adapted to the level of difficulty
- Attractive visual and audio representations with high authenticity and realism
- Appropriate rewards
- Surprising developments
- Choice of game characters
- Support for social interactions
- Support of the subjective feeling of control
- Use of machine learning and AI for real-time customisation

Furthermore, many design rules and principles exist for Games in general (e.g., Koster, 2013; Schell, 2020), serious games (e.g. Mellecker et al., 2013), or specific learning games (e.g., Müller, Petko & Götz, 2011; Watt & Smith, 2021). These recommendations are taken into account in the present project. The following list contains important rules and principles:

- Explicit links to the curriculum and the learning objectives of the course
- Diverse game-related tasks, e.g. testing and observation
- Multiple and flexible attempts for problem solution
- Scoring or rewards - based on learning (not on game performance)
- Structured reward system and in-Games rewards
- Stimuli for game-related reflections
- Appropriate playing time
- Balance of visual elements, immersion and learning (cognitive load)
- Low technical requirements (usability, playability)
- Enough freedom of movement and decision making (self-determination)
- Creation of opportunities for comparison and discussion of own results
- Creation of opportunities for social learning (cooperative play)
- Target group-specific game designs, e.g. playing with and against others

In our own lecture "Introduction to diagnostics" (summer term 2023), the students articulated the following wishes and expectations regarding game design:

- Creative background story
- Reward system
- Own movement in 3D space
- Motivating interactivity
- Various tasks
- Choice of different solutions with presentation of the relevant consequences
- Measurement of reaction times to tasks
- Short visualisations
- Flexible group formation depending on the situation

Diagnostics concept

The diagnostics concept is based on a competency model (Anderon et al., 2001). The concept includes five knowledge categories (reproduction, reflection, application, evaluation, and development; Tab. 3), three content categories (facts/terms, concepts/models/theories, procedures/techniques/methods) and three degrees of difficulty (basic, medium, excellent).

Tab. 3. *Knowledge components.*

Knowledge → Content ↓	Reproduction	Reflection	Application	Evaluation	Development
Facts & terms					
Concepts, models & theories					
Procedures, techniques & methods					
Game element	**Quiz**	**Quiz**	**Play**	**Quiz & Play**	**Play**

The competency model is compatible with algorithmic processes such as Artificial Intelligence (e.g., ACT-R, Ritter et al., 2019), which enable an automatic diagnosis and an individualized adaptation of game episodes and modes.

Summary

The StIL project "The Analyst - Serious Games as Learning Diagnostics" addresses the effectiveness and attractiveness of an educational game for diagnostics in human sciences. Content, learning and game elements aim to achieve a balance between learning and game effects. Key elements are variable game scenes based on the narrative "scientific internship" with continuous and motivating feedback. Knowledge is imparted via slides, recordings, quizzes and videos. To support the gaming experience, relevant components, measures and principles from the games, serious games and learning games literature are taken into account. The diagnostic concept comprises five knowledge components, three content categories and three levels of difficulty.

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