

University of Stuttgart

Institute of Software Engineering (ISTE),
Software Quality and Architecture Group (SQA)

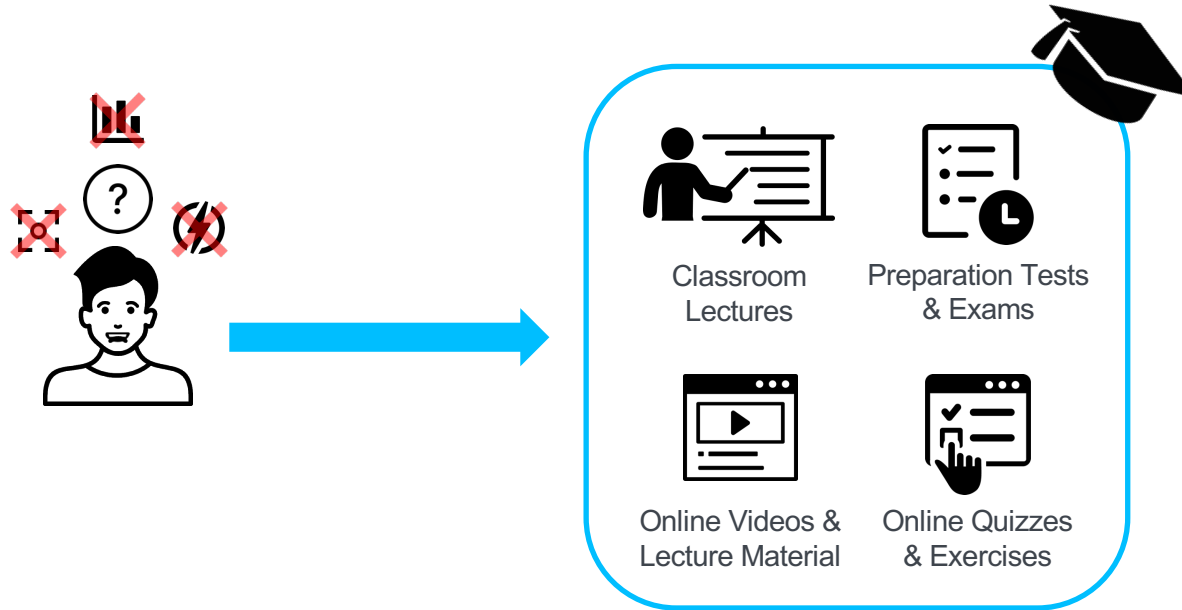
Niklas Meißner, Sandro Speth, Uwe Breitenbücher



An Intelligent Tutoring System Concept for a
Gamified e-Learning Platform for Higher
Computer Science Education

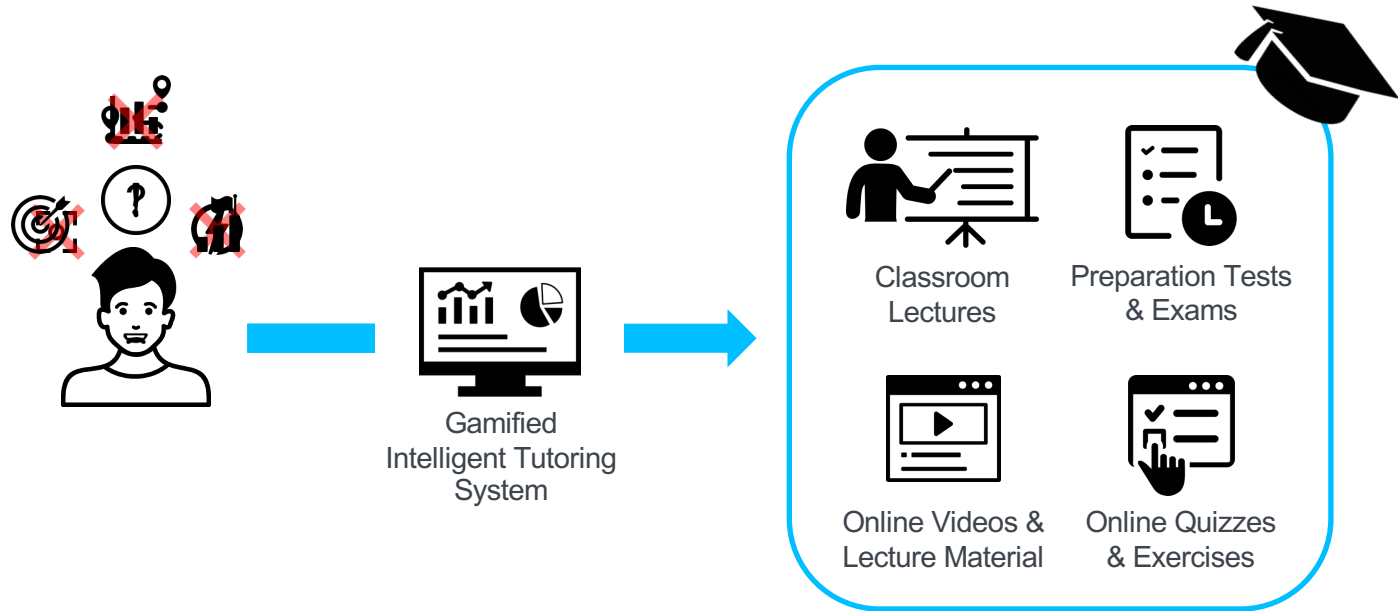
Motivation

Problem Description and Goal



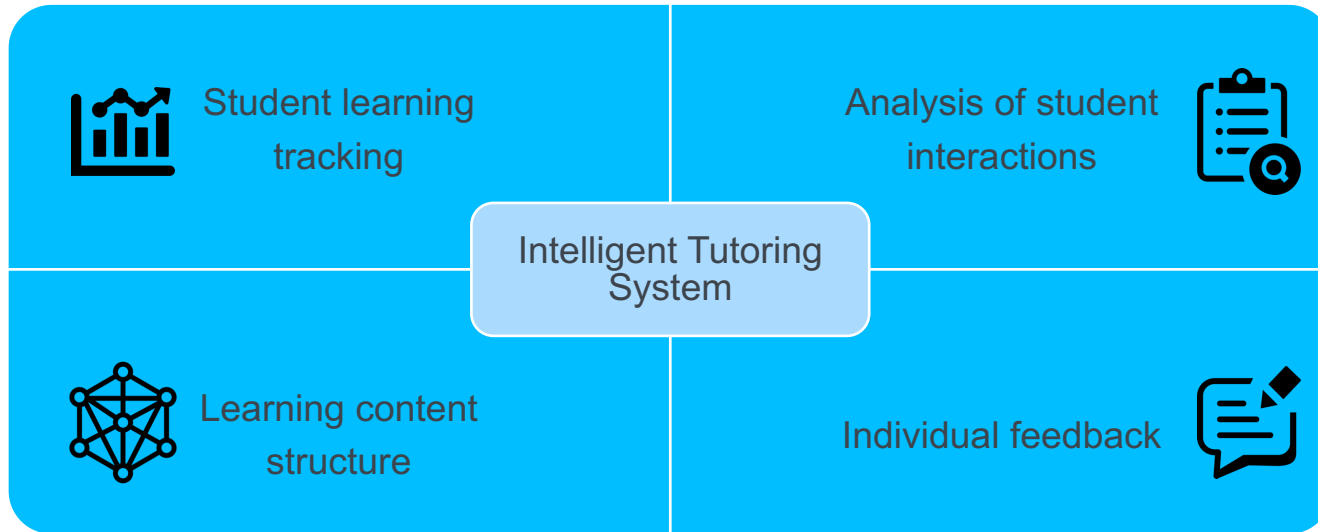
Motivation

Problem Description and Goal



Motivation

Intelligent Tutoring Goals



Foundation

Interactive Training Remote Education Experience (IT-REX) [1]



[1] Sandro Speth et al. – „IT-REX — A Vision for a Gamified e-Learning Platform for the First Semesters of Computer Science Courses“ (2022)

Related Work

Tools



Unstructured Content

Plugins for student statistics

Focus on repetition

Complicated to use

Not possible to publish own content

Only for high school education

Structured Content

Not motivating to keep up learning

No feedback on students' performance

Related Work Tools



Unstructured Content

Plugins for student
statistics

Focus on repetition

Complicated to use

**Not possible to
publish own content**

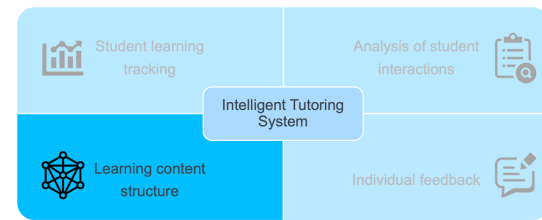
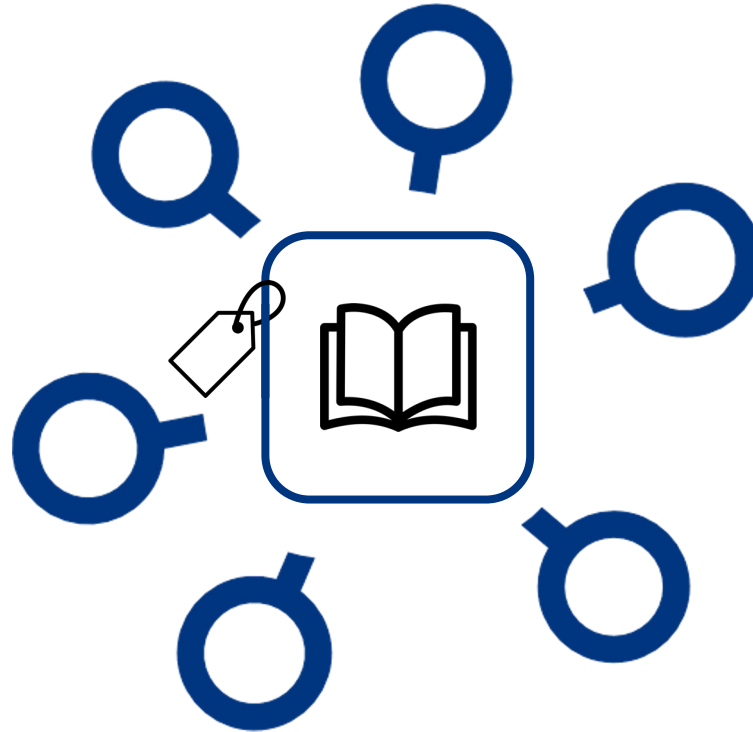
**Only for high school
education**

Structured Content

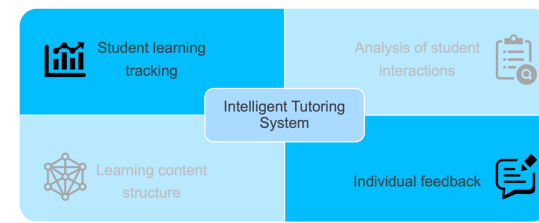
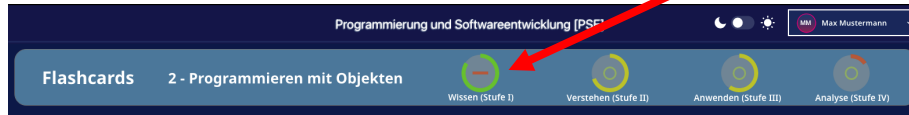
**Not motivating to
keep up learning**

No feedback on
students' performance

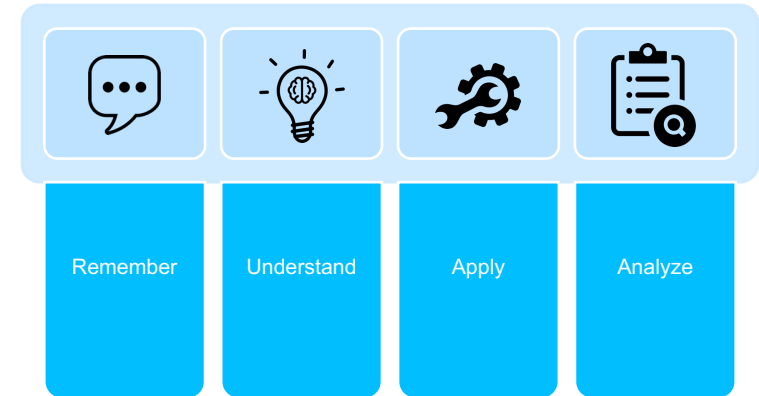
Preparation of Course Material Tagging



Skill Levels

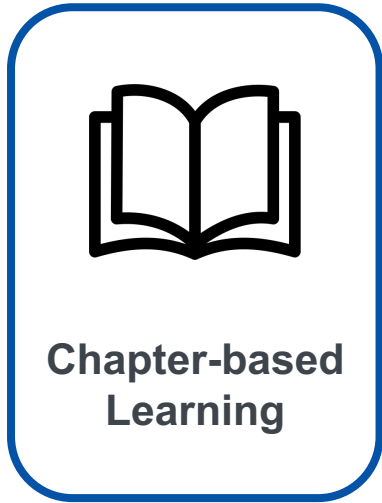
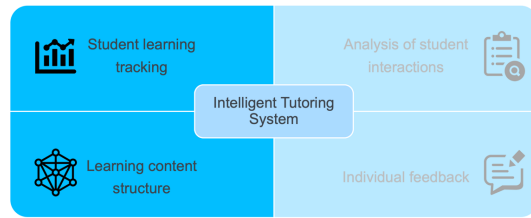


Bloom's Taxonomy



Learning Strategies

Chapter-based Learning



The screenshot shows the IT-REX e-learning platform interface. The main content area displays the course "Programmierung und Softwareentwicklung [PSE]". The interface is organized into weeks and chapters.

Course Overview: Programmierung und Softwareentwicklung [PSE]

Weeks:

- Woche 1 (01.03.2021 - 07.03.2021)
- Woche 2 (08.03.2021 - 14.03.2021)
- Woche 3 (15.03.2021 - 21.03.2021)

Chapter 1: Einführung und Motivation (Woche 1)

- Was ist PSE?.mp4 (Woche 1 (01.03.2021 - 07.03.2021)) - Completed
- Legends für Vorlesungsfolien.mp4 (Woche 1 (01.03.2021 - 07.03.2021)) - Completed
- Motivation für PSE.mp4 (Woche 1 (01.03.2021 - 07.03.2021)) - Completed

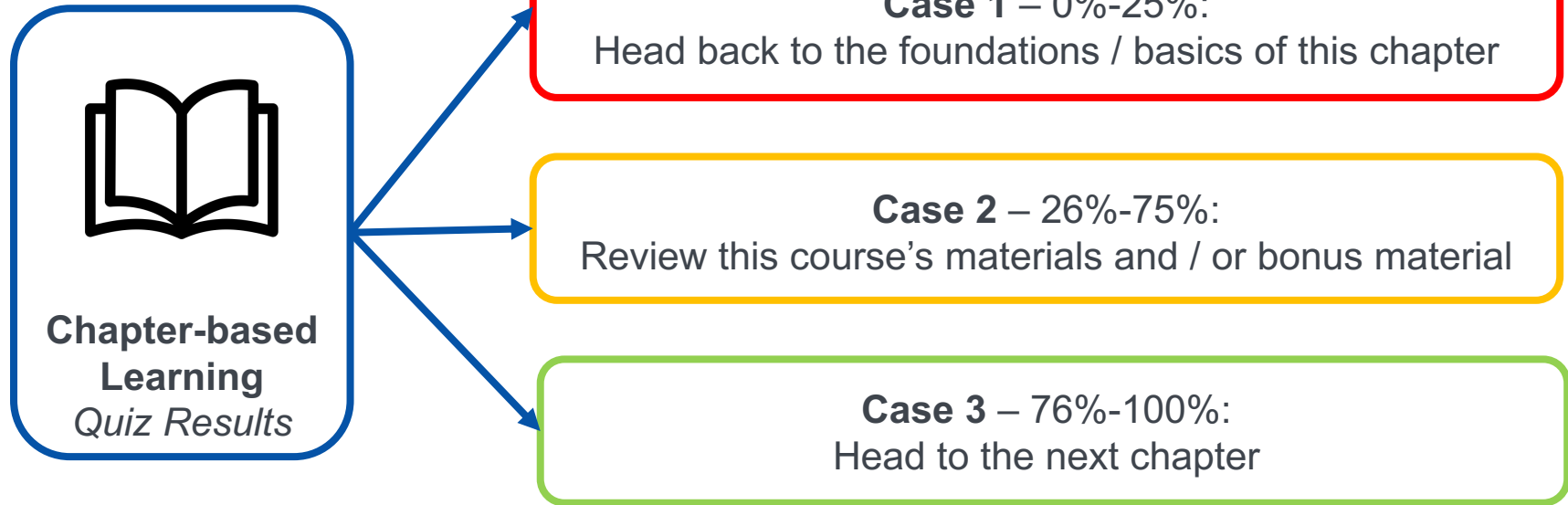
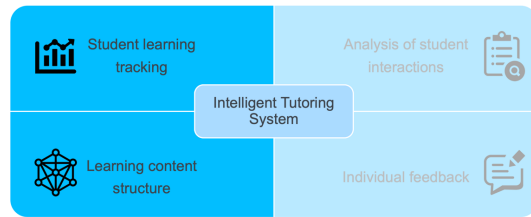
Chapter 2: Programmieren mit Objekten (Woche 2)

- Mit Objekten arbeiten.mp4 (Woche 2 (08.03.2021 - 14.03.2021)) - Completed
- Einführung in den Hamstersimulator.mp4 (Woche 2 (08.03.2021 - 14.03.2021)) - Started
- Beispiel Hamsterprogramm.mp4 (Woche 2 (08.03.2021 - 14.03.2021)) - No Progress
- Quiz - Programmieren mit Objekten (Woche 2 (08.03.2021 - 14.03.2021)) - No Progress

Chapter 3: Struktur von Programmen (Woche 3)

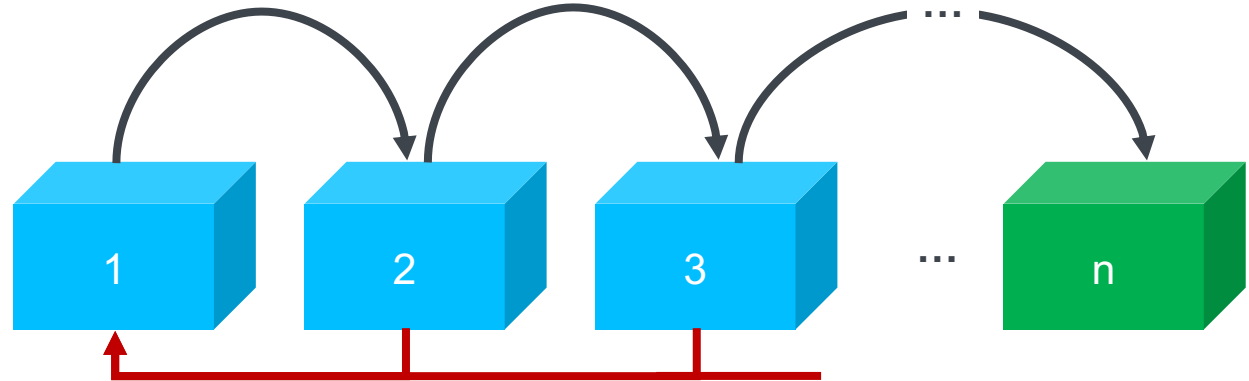
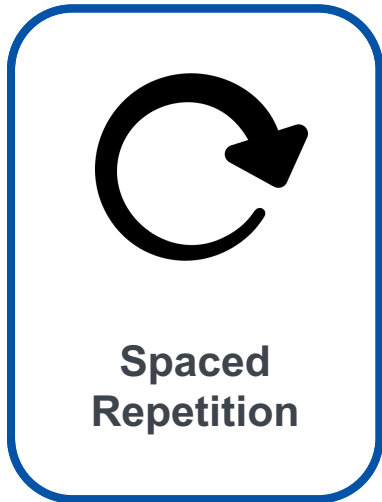
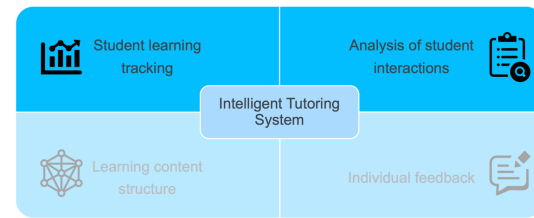
Learning Strategies

Chapter-based Learning



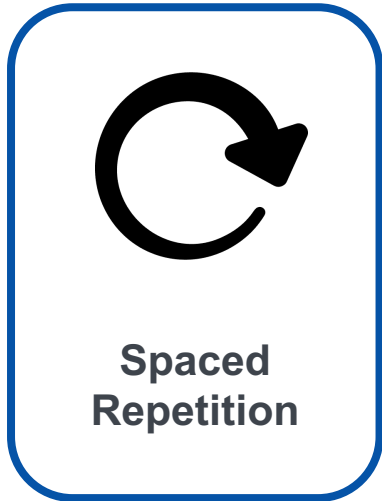
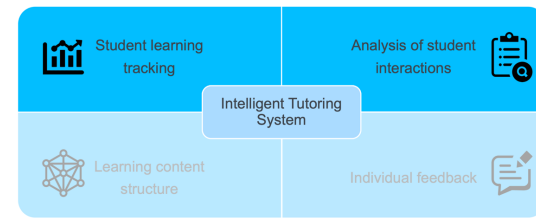
Learning Strategies

Spaced Repetition



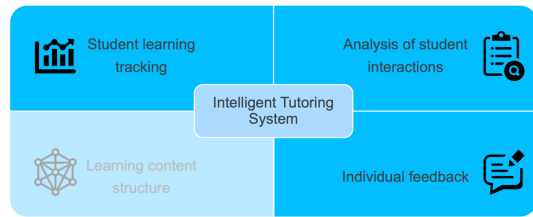
Learning Strategies

Spaced Repetition



The screenshot shows the IT-REX application interface. On the left is a dark sidebar with navigation options: Home, Join course, Last accessed course, My Courses (listing various subjects), Quick settings, and Logout. The main content area is titled 'Programmierung und Softwareentwicklung [PSE]' and features a 'Flashcards' section for '2 - Programmieren mit Objekten'. This section includes progress indicators for four levels: Wissen (Stufe I), Verstehen (Stufe II), Anwenden (Stufe III), and Analyse (Stufe IV). A question card is displayed with the text 'Welche der folgenden Aussagen über Kommandos sind richtig?' and four options: 'Sie geben einen Wert zurück.', 'Sie können den Zustand anderer Objekte verändern.', 'Sie sind idempotent.', and 'Sie ändern den Zustand des Objektes auf dem sie aufgerufen wurden.' At the bottom of the card are three buttons: 'Back to Home', 'Skip', and 'Next'. Red arrows point from the 'Wissen (Stufe I)' indicator to the question card, and from the 'Skip' and 'Next' buttons back to the question card.

Scoring System



Course

Chapter

Remember



0-100

Understand



0-100

Apply



0-100

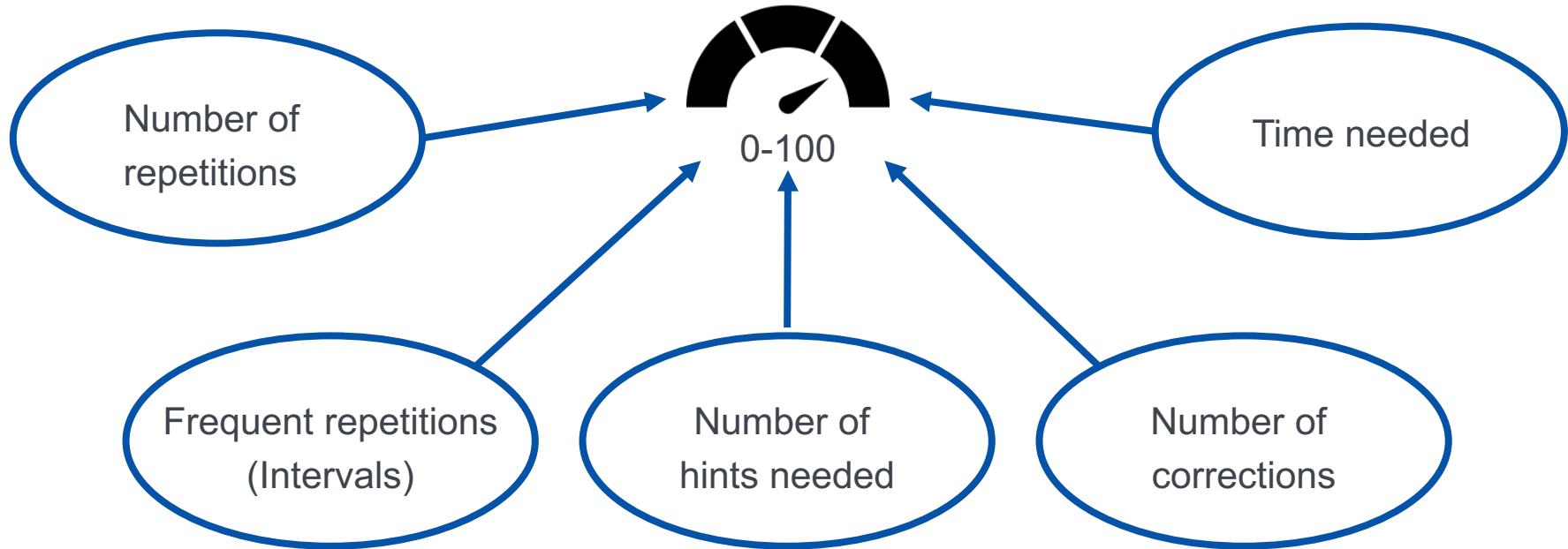
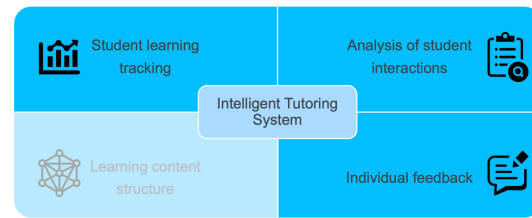
Analyze



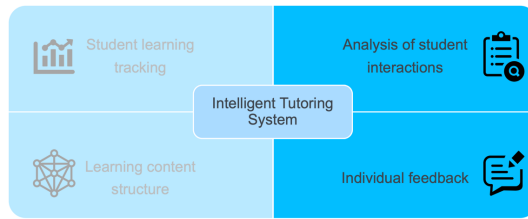
0-100

Scoring System

Calculation of Hidden Score



Feedback Strategy



Levels of decision tree

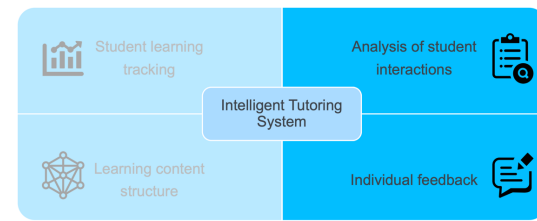
- Student Achievement
- Task Level
- Timing Of Feedback
- Prior Knowledge
- Amount Of Repetitions
- Hint Type



Feedback types

- Verification
- Correct Response
- Try Again
- Topic Contingent
- Response Contingent

Feedback Strategy



The screenshot shows a quiz interface for "Programmierung und Softwareentwicklung [PSE]". The user is identified as "Max Mustermann". The quiz is titled "Quiz - Schnittstellen" and is on "Attempt: 2".

The progress bar shows four stages: Wissen (Stufe I), Verstehen (Stufe II), Anwenden (Stufe III), and Analyse (Stufe IV). The "Verstehen (Stufe II)" stage is highlighted with a red arrow.

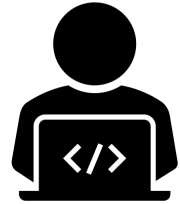
Feedback text: "You have reached 62,5% of 100%
5 of 8 questions are completely right"

Recommendation text: "You answered 62,5% of the questions correctly. Before you try again this quiz, you should review contents of chapter 4 again to improve your next turn."

- [Repeat the video on „Arten von Schnittstellen“](#)
- [Repeat the video on „Javadoc“](#)

Red arrows point from the "Verstehen (Stufe II)" stage and the first recommendation link to the "Intelligent Tutoring System" box in the top right diagram.

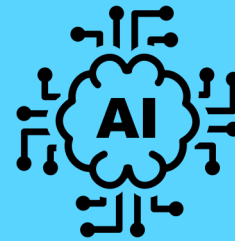
Outlook – IT-REX



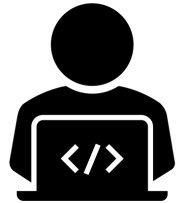
Gamification



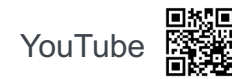
IT-REX



Intelligent Tutoring



Outlook – Gamify-IT



Find the Bug

```
public static int main( String... args ) {  
    System.out.println( null );  
}
```

Finish

Hey



I'm having big trouble with this code. Can you help me finding all bugs?



I think I found the bug. Is the program running?



Probably not.



With



00:24

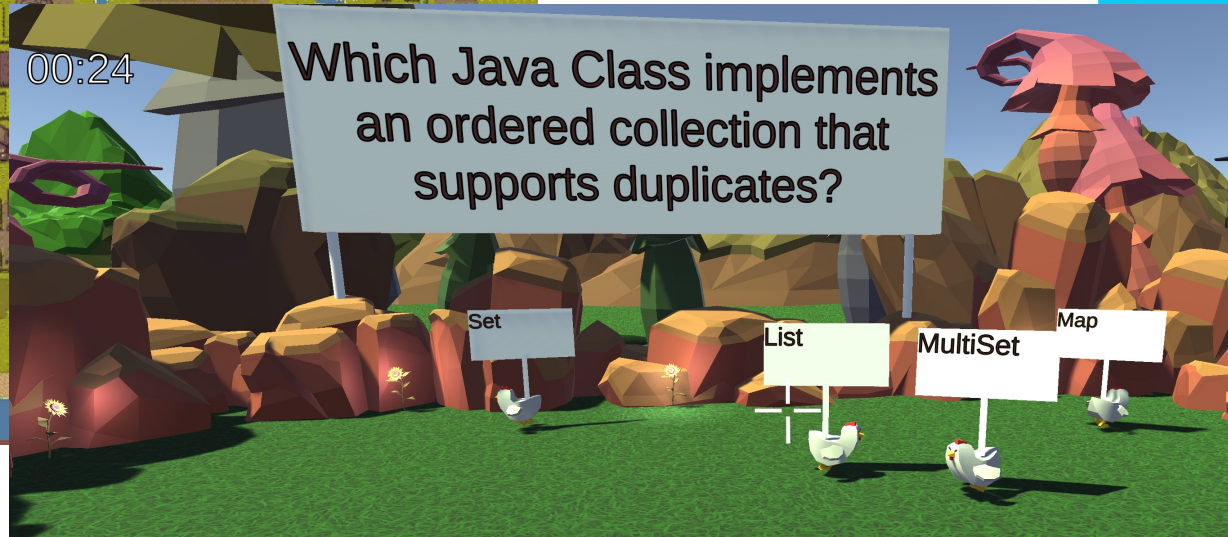
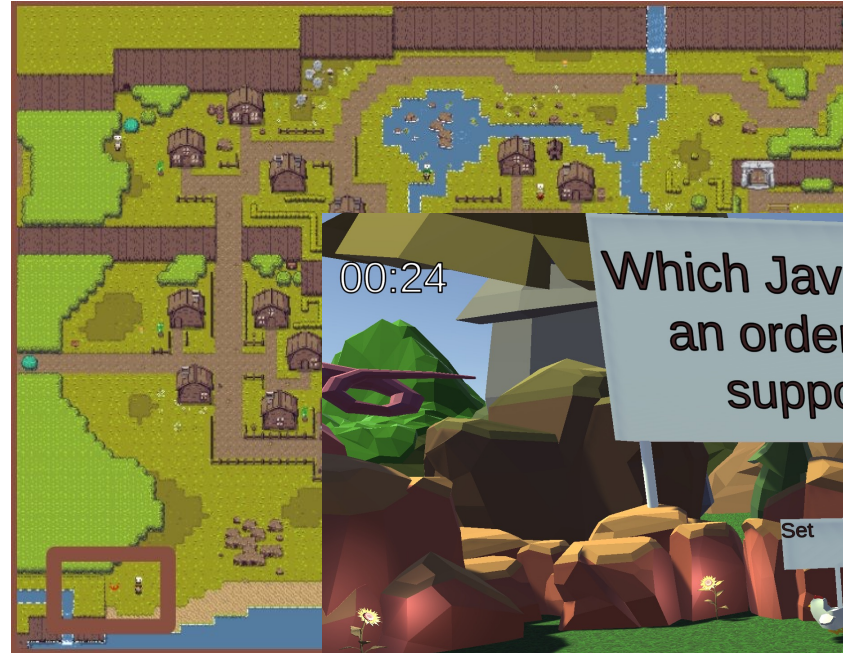
Which Java Class implements an ordered collection that supports duplicates?

Set

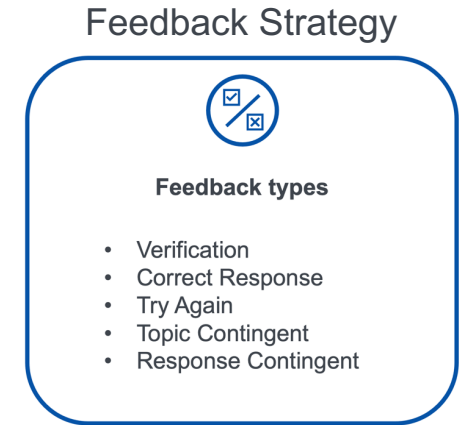
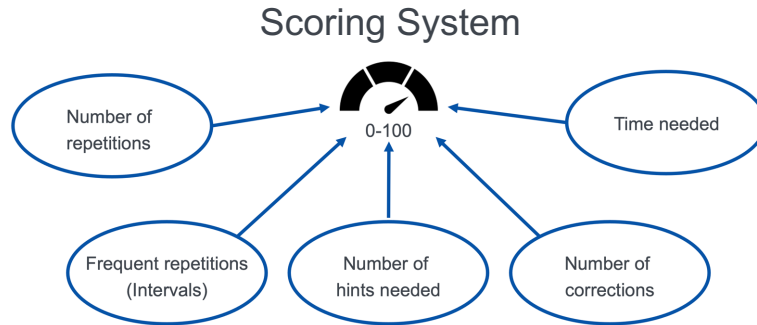
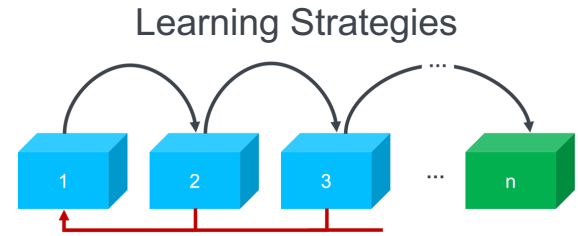
List

MultiSet

Map



Conclusion





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Thank you!



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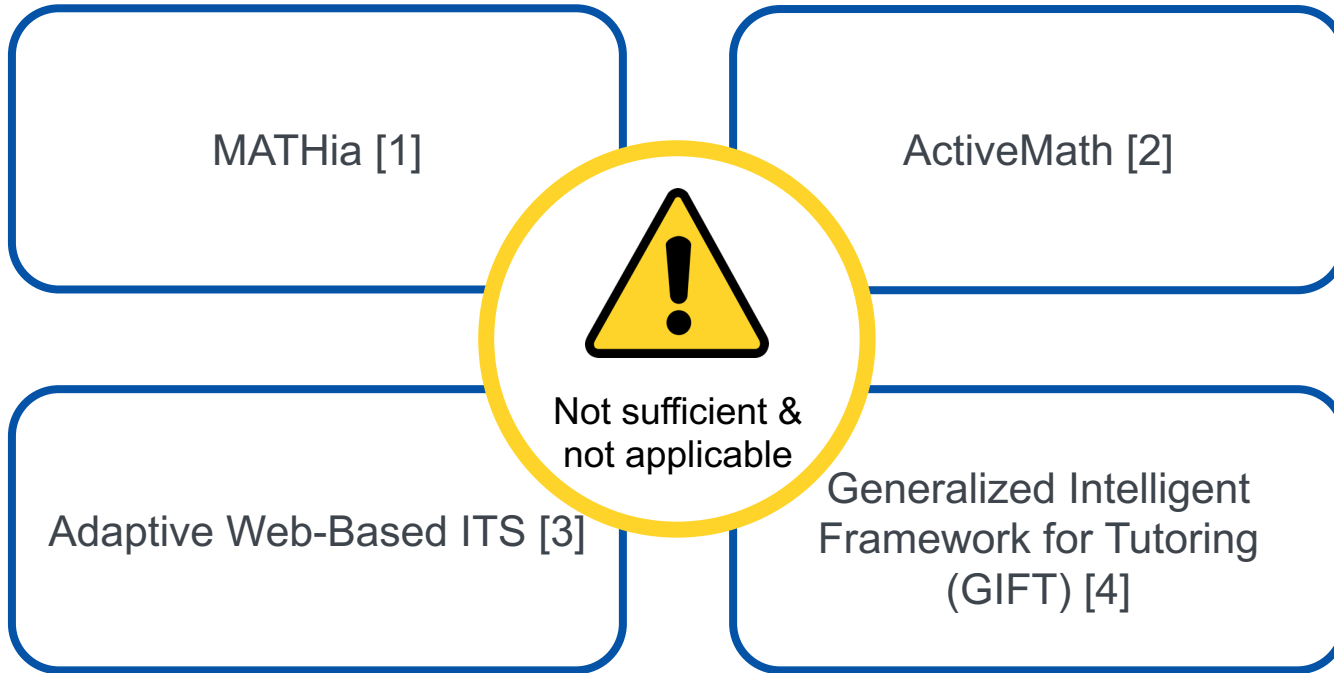
Universitätsstraße 38,

70569 Stuttgart

Room 1.252

BACKUP SLIDES

Related Work



[1] Carnegie Learning – „MATHia“ (2021)

[2] Erica Melis, Jörg Siekmann – „ActiveMath: An Intelligent Tutoring System for Mathematics“ (2004)

[3] Kunyanuth Kularbphettonga et al. – „Developing an Adaptive Web-Based Intelligent Tutoring System using Mastery Learning Technique“ (2014)

[4] Robert Sottolare, Heather Holden – „Motivations for a Generalized Intelligent Framework for Tutoring (GIFT) for Authoring, Instruction and Analysis“ (2013)