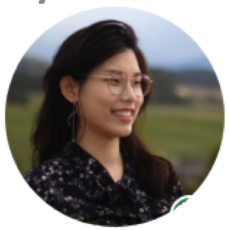
An Open CS1 Learning Platform to Promote and Incentivize Deliberate Practice

Keyvan Khademi, Mathew de Vin, Carson Ricca, Abhineeth Adiraju, Lydia Lin, Opey Adeyemi, Bowen Hui



THE UNIVERSITY OF BRITISH COLUMBIA

Computer Science

Motivation

- Increased enrollment in CS1 classes
- Many students find CS1 concepts difficult to master and workload too demanding
- Some students continue to ask for more practice questions
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- Our solution: Course gamification platform {>.<}
  - Platform for additional practice
  - Combines concepts of mastery learning with gamification
  - Instructor can choose to count practice for extra marks or not
  - Students can get extra practice at minimal cost to the instructor

Related Work: OER for CS

- OER benefits
  - Save instructor time in preparation
  - Save students money
  - Offer equitable learning opportunities
  - Support students in achieving same or better learning outcomes

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- OER in CS:
  - Used in formal and informal settings
  - Survey found main criterion for selection is quality of content
  - Other factors: topic coverage, level of difficulty, details available, programming language, presence of examples, content recency
  - Most used resources: assignments, problems, code examples
  - Most common barrier is lack of clarity in copyrights
  - Recent efforts in open question banks are limited (quantity and type)

Related Work: Gamification Platforms

- Popular experimentation in CS education
- Generally positive impact on learning
  - Attendance, time spent practicing, activities completed, enrollment, self-reported enjoyment
  - Often led to improved programming knowledge (grades)

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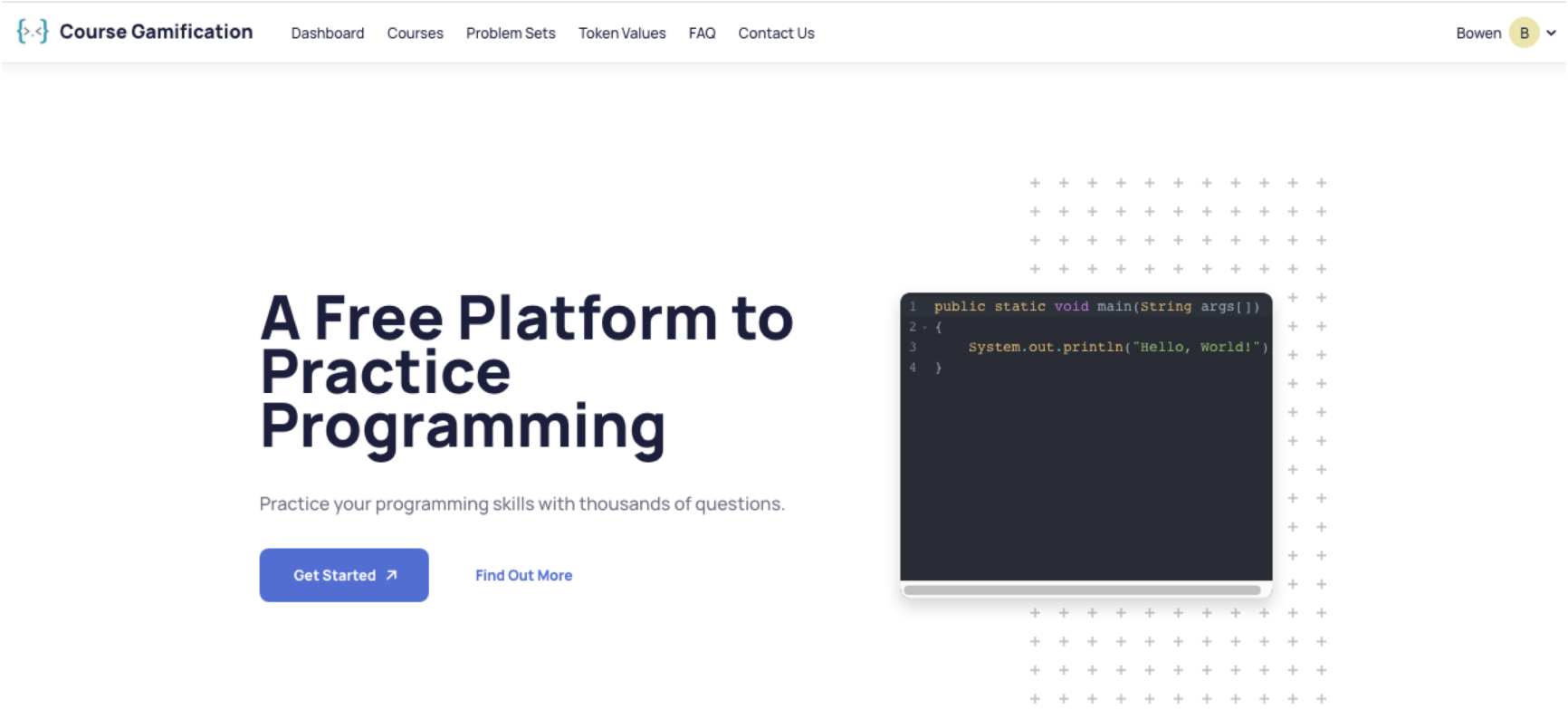
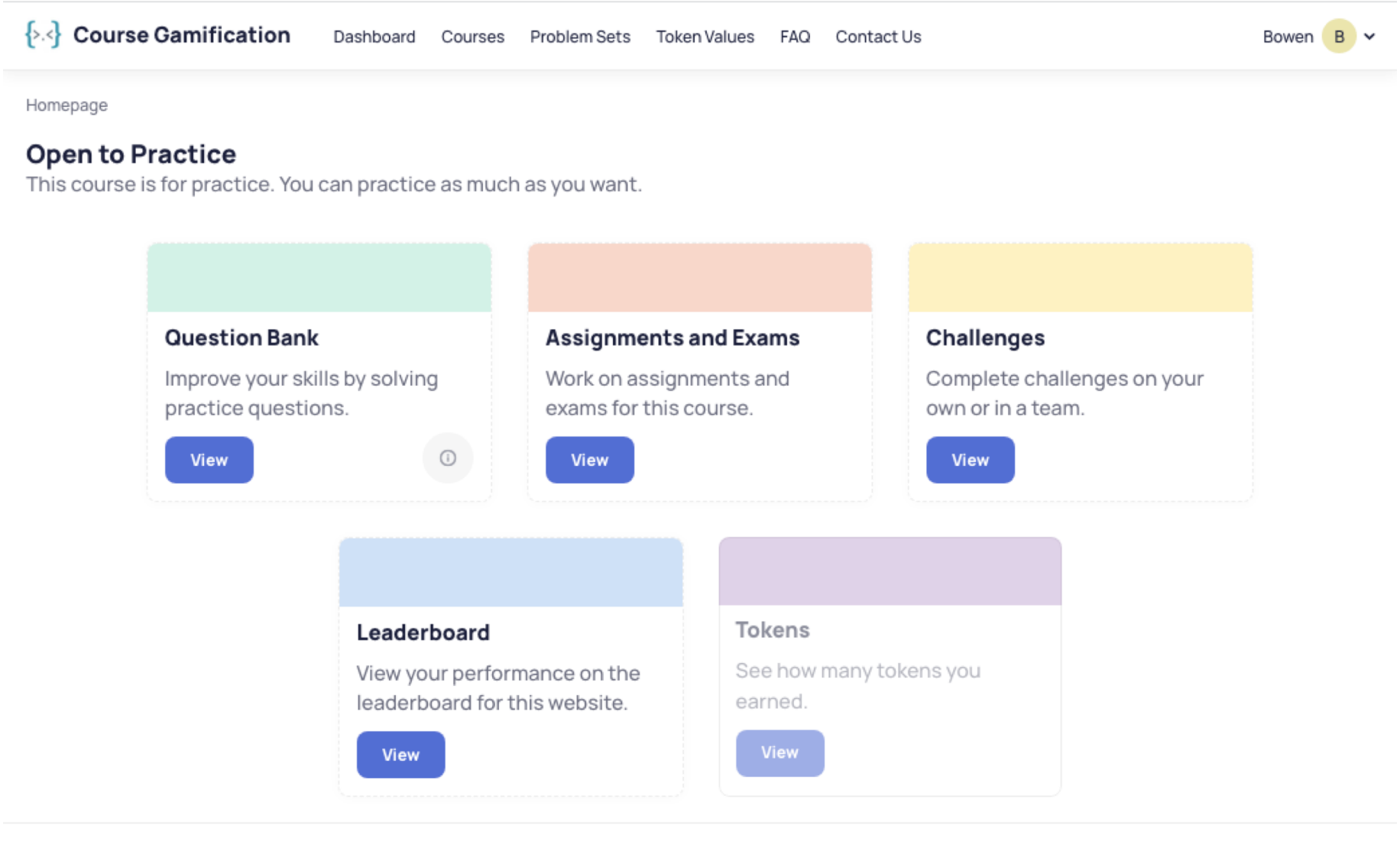
- Popular experimentation in CS education
- Generally positive impact on learning
  - Attendance, time spent practicing, activities completed, enrollment, self-reported enjoyment
  - Often led to improved programming knowledge (grades)
- Lack of theoretical understanding of gamification on learning
  - Concern with use of extrinsic rewards
  - Over-engagement in playing rather than learning
  - Other negative effects: indifference, loss of performance, undesired behavior, declining effects

Our System: Course Gamification

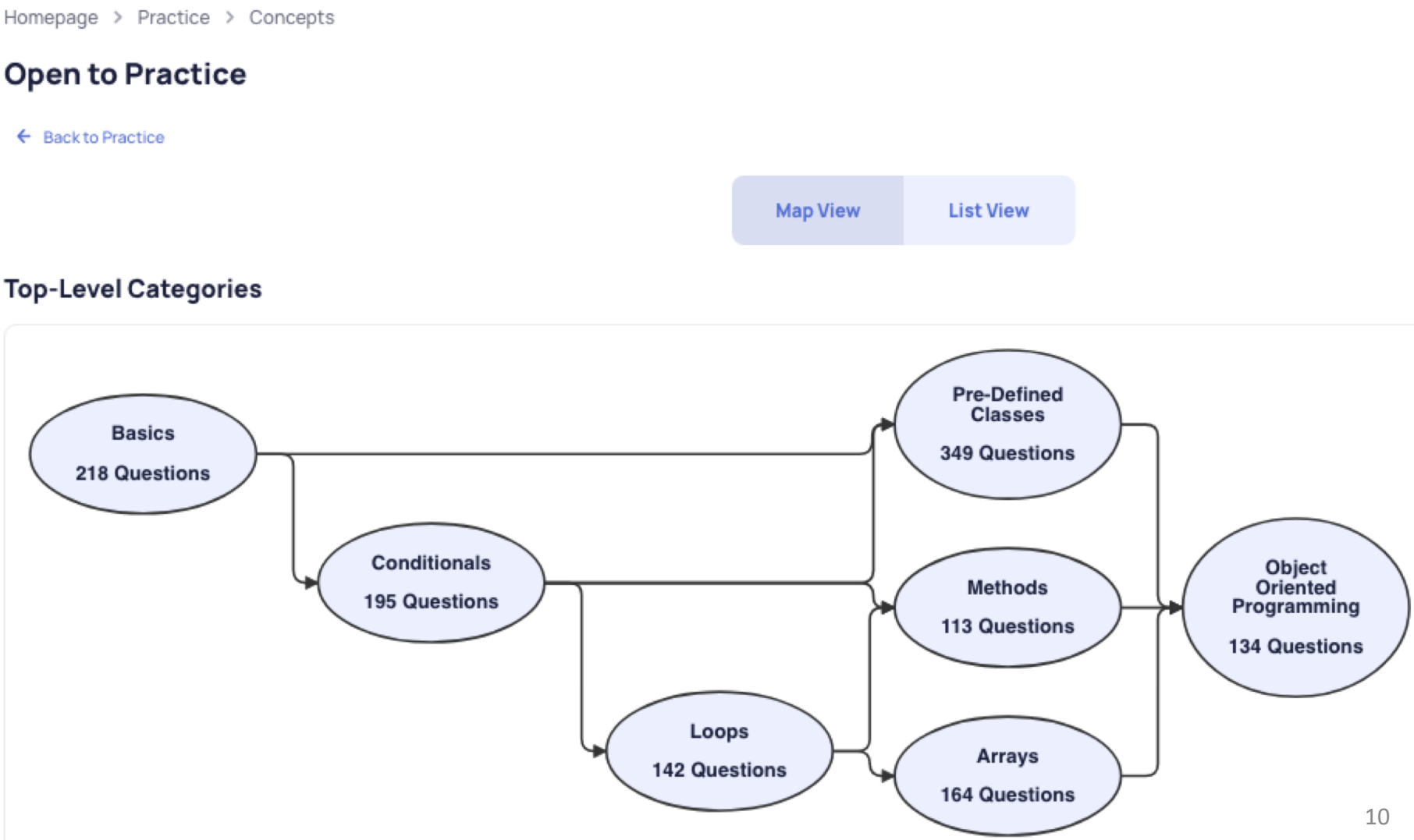
- https://gamification.ok.ubc.ca/



Course Homepage



Concept Map Navigation



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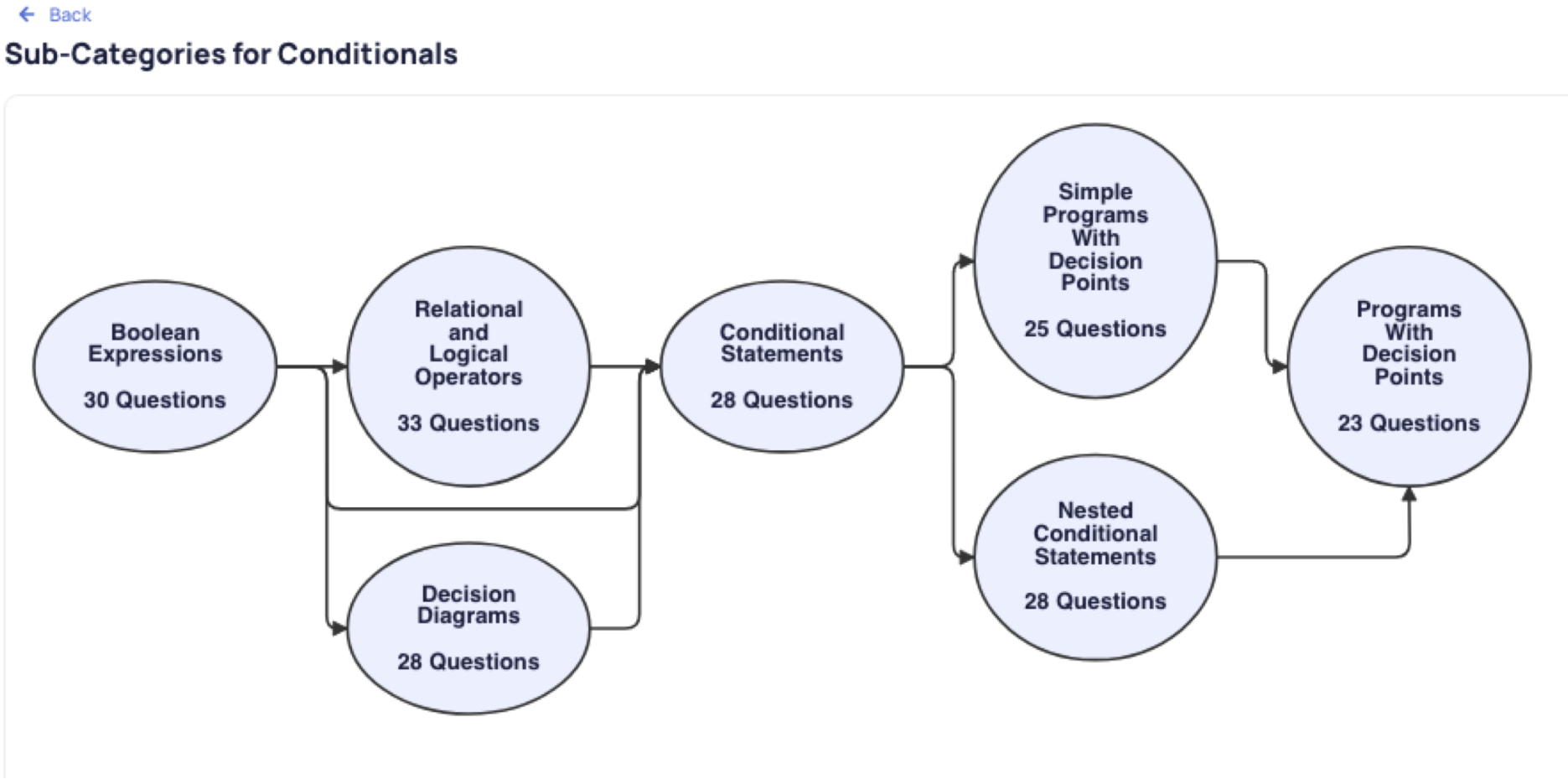
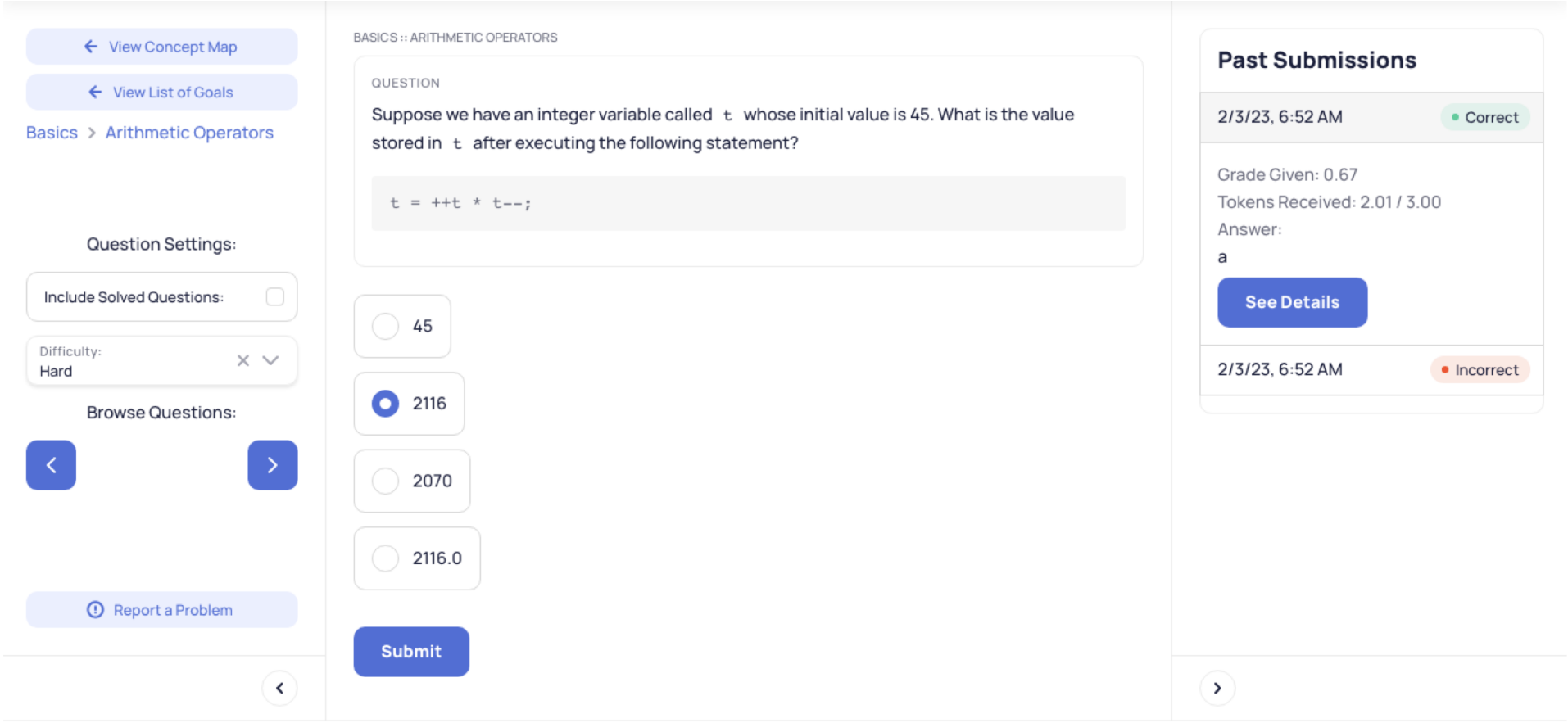
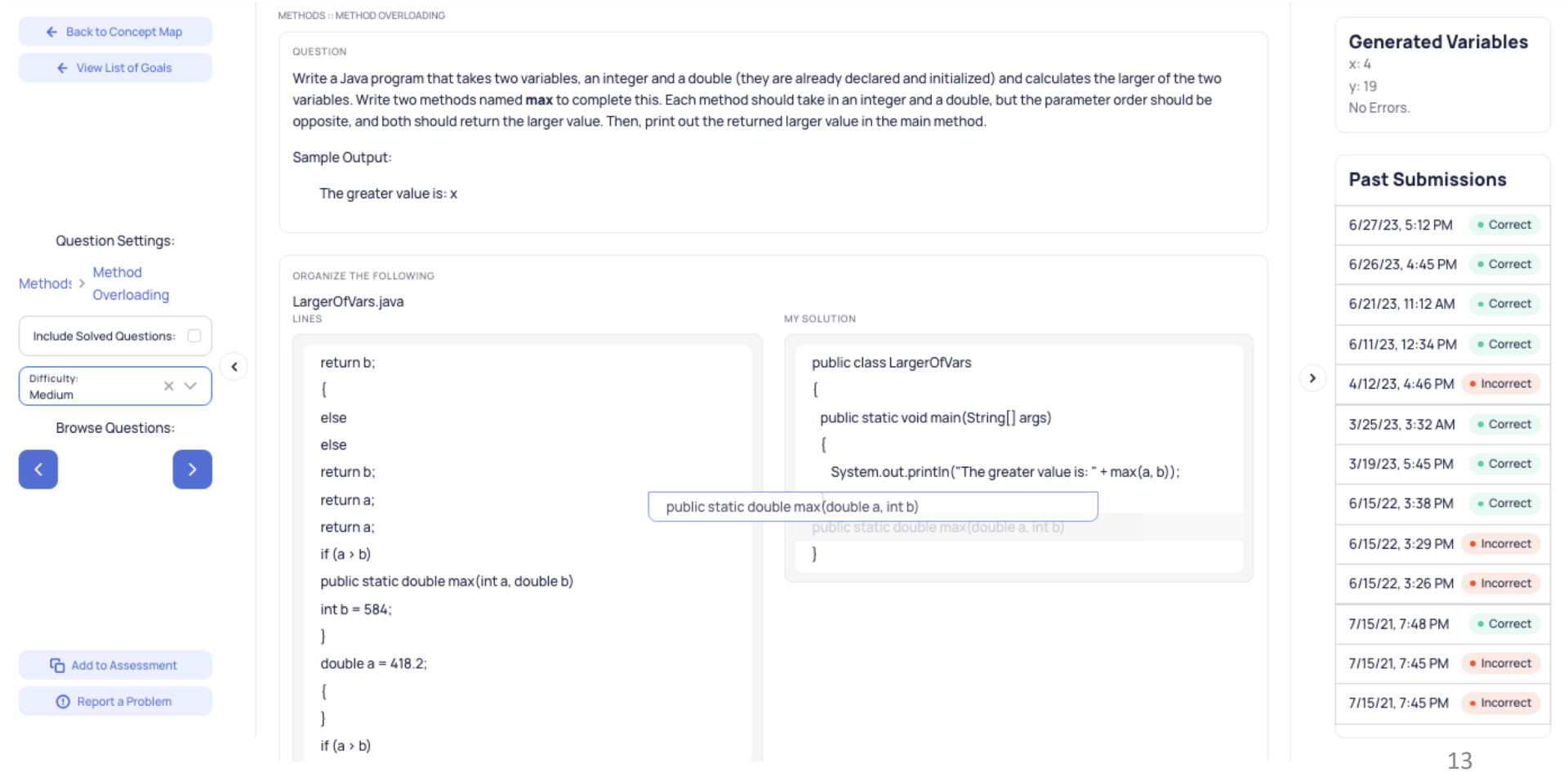


Multiple Choice Questions

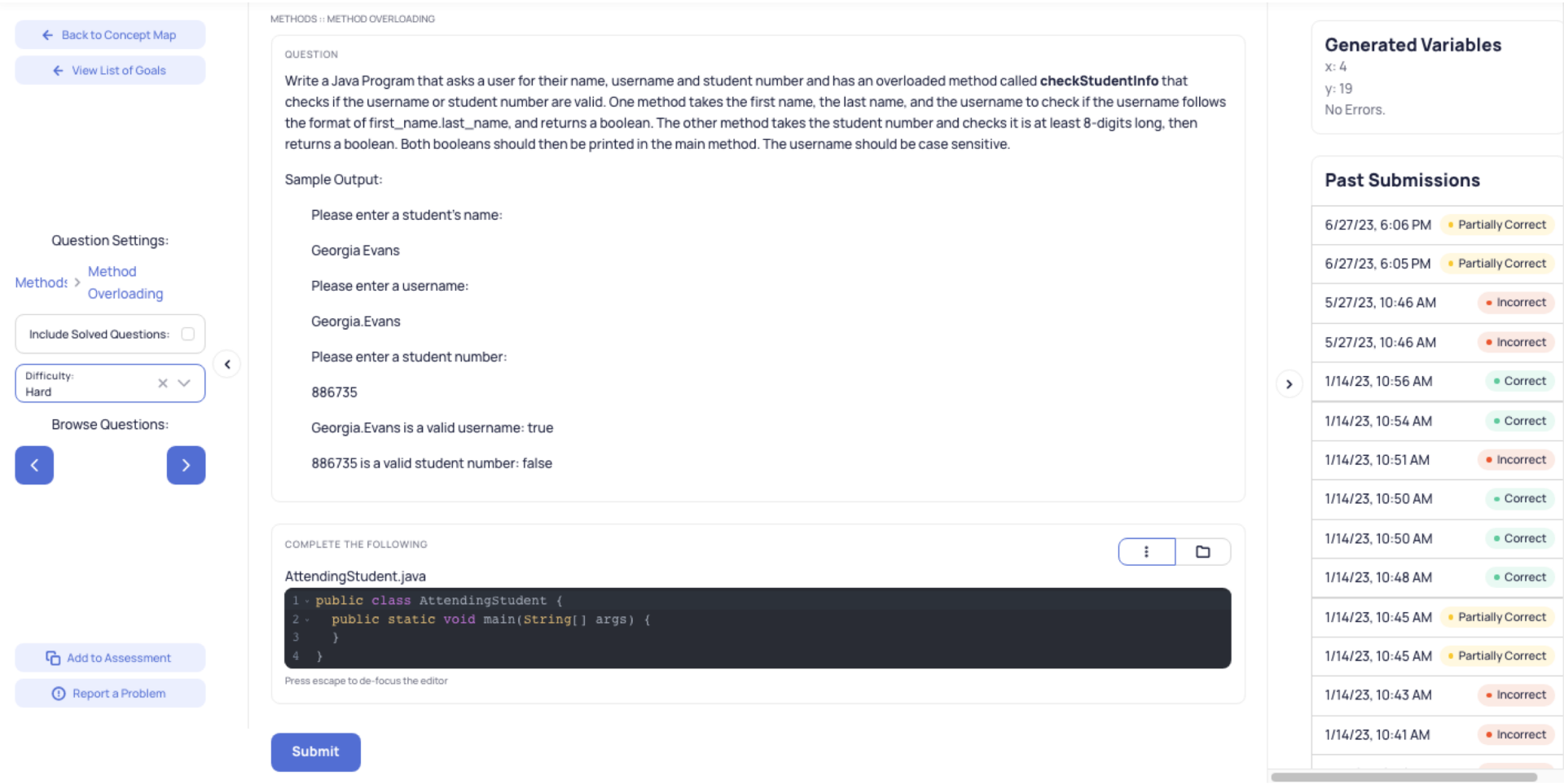


Parson's Questions

- Drag and drop lines of code to form working program



Written Programming Questions

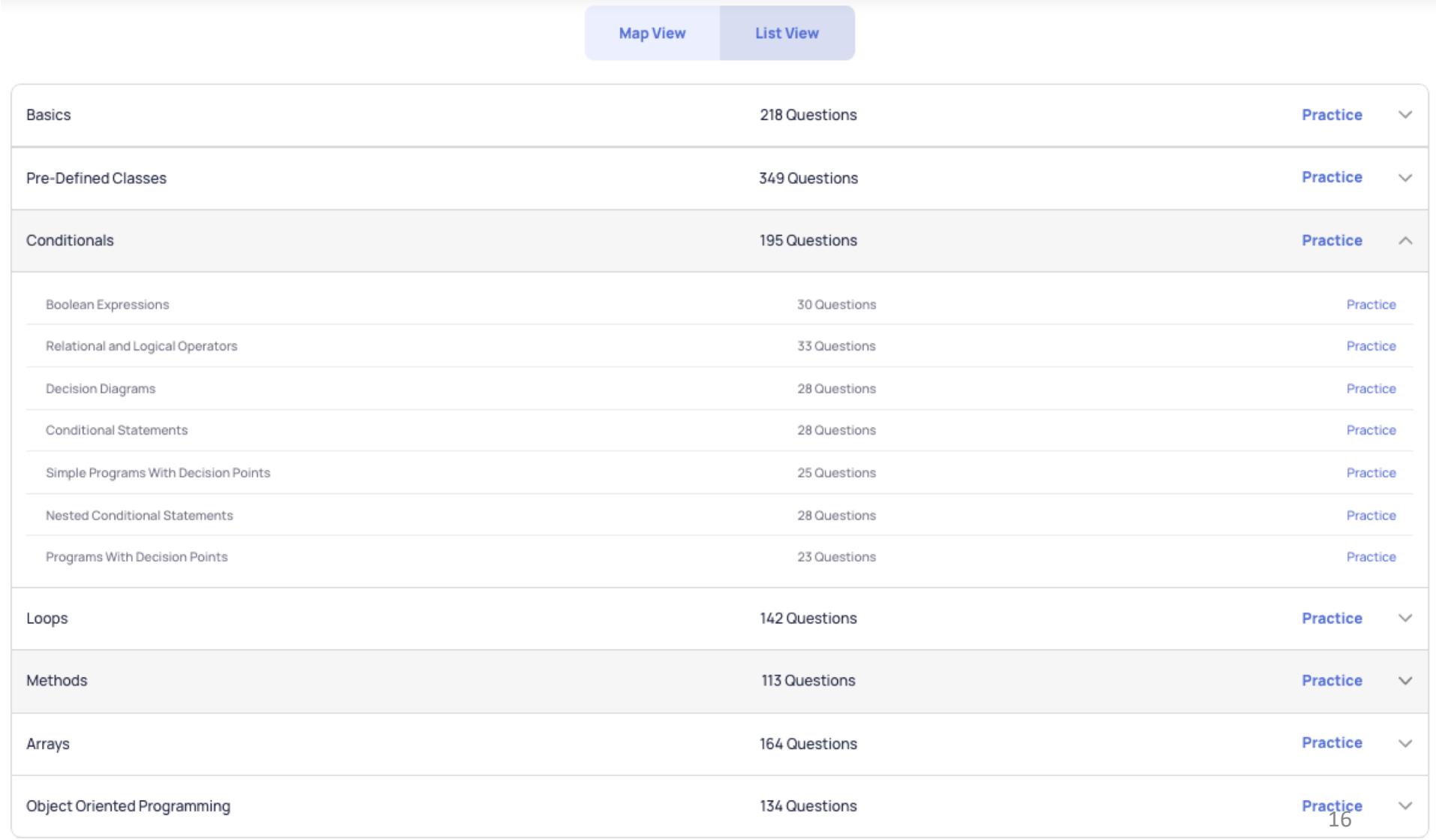


Immediate Feedback via JUnit Testing

- Allows for incremental programming
- JUnit extension beyond output testing

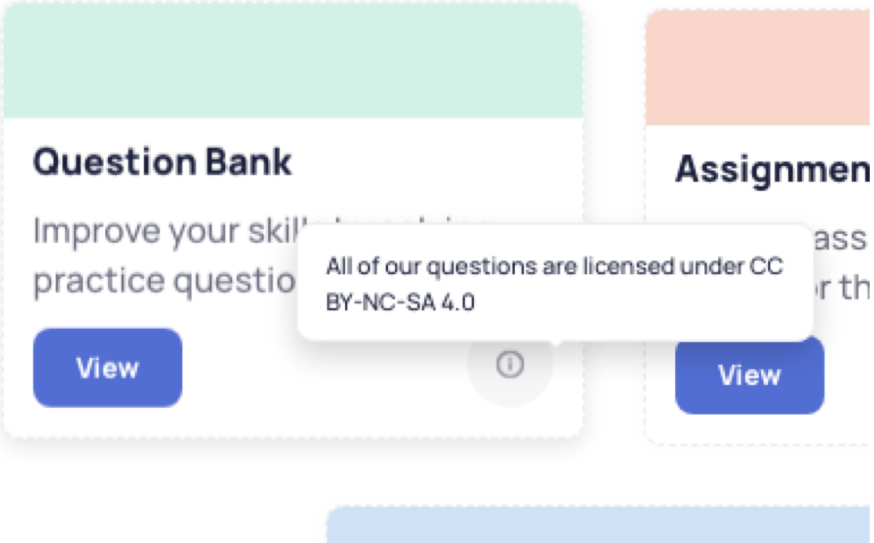
- See Wednesday's discussion paper (Adeyemi et al.)

Alternate List View Navigation



Java Question Bank

Topic	MCQs	Programming Questions	Subtotal
Basics	204	0	204
Conditionals	160	24	184
Pre-Defined Classes	263	80	343
Loops	75	66	141
Methods	59	70	129
Arrays	60	105	165
Introductory OOP	144	210	354
Total:	965	555	**1,520**



Personal Analytics

Personal Statistics

Accomplishments	Total
Questions Completed	2
Challenges Completed	0
Tokens Earned	34.9
Goals Completed	0

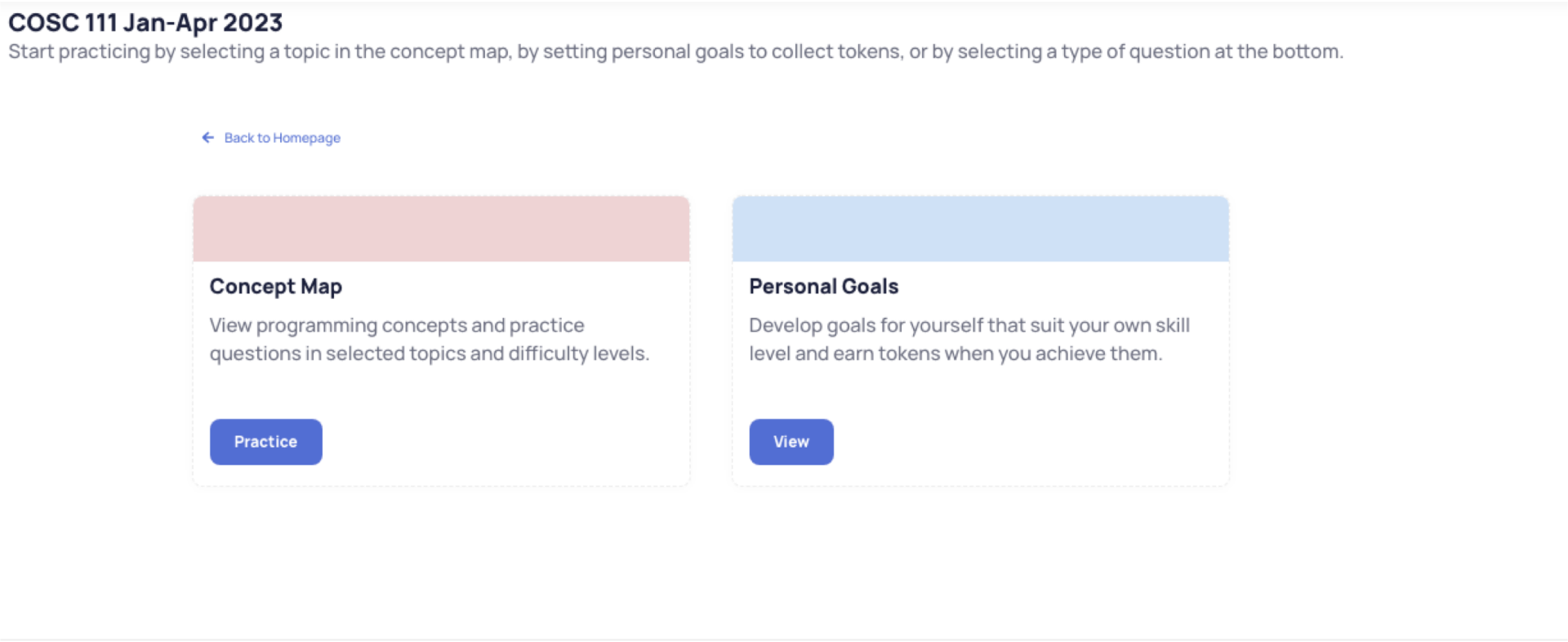
Question Statistics

Difficulty	Number Completed
Easy	2
Medium	0
Hard	0

Type	Number Completed
Multiple Choice Questions	2
Parson's	0
Java	0

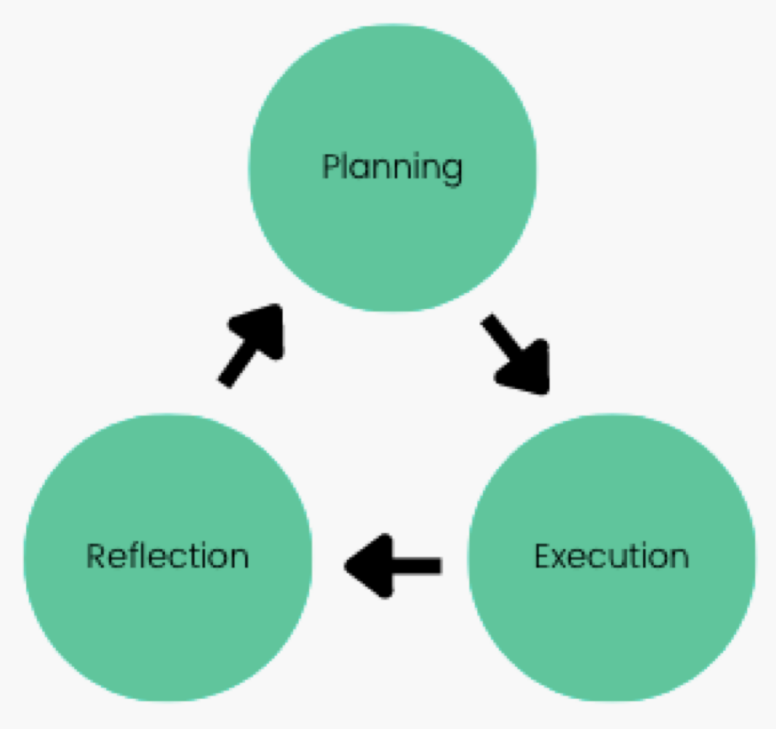
Category	Number Completed
Basics	1
Pre-Defined Classes	0
Conditionals	1
Loops	0
Methods	0
Arrays	0
Object Oriented Programming	0

Freeform Practice

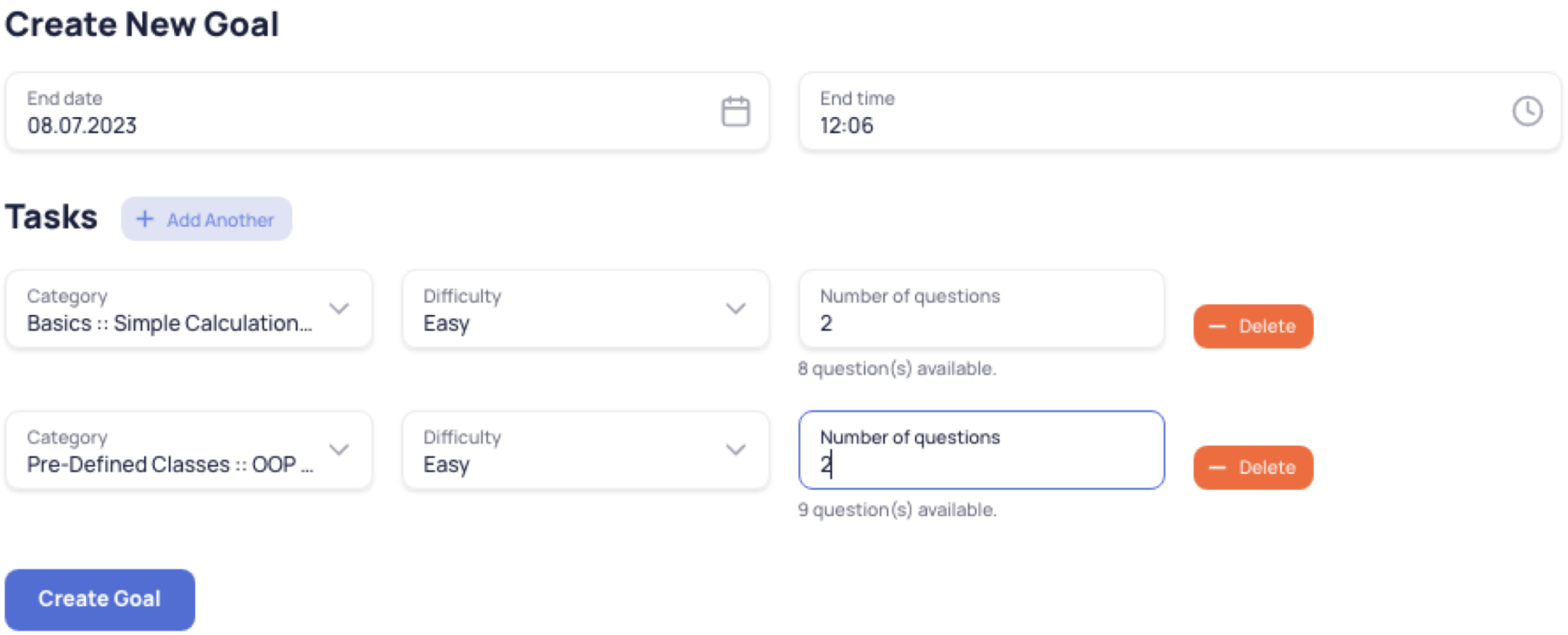


Self-Regulated Learning

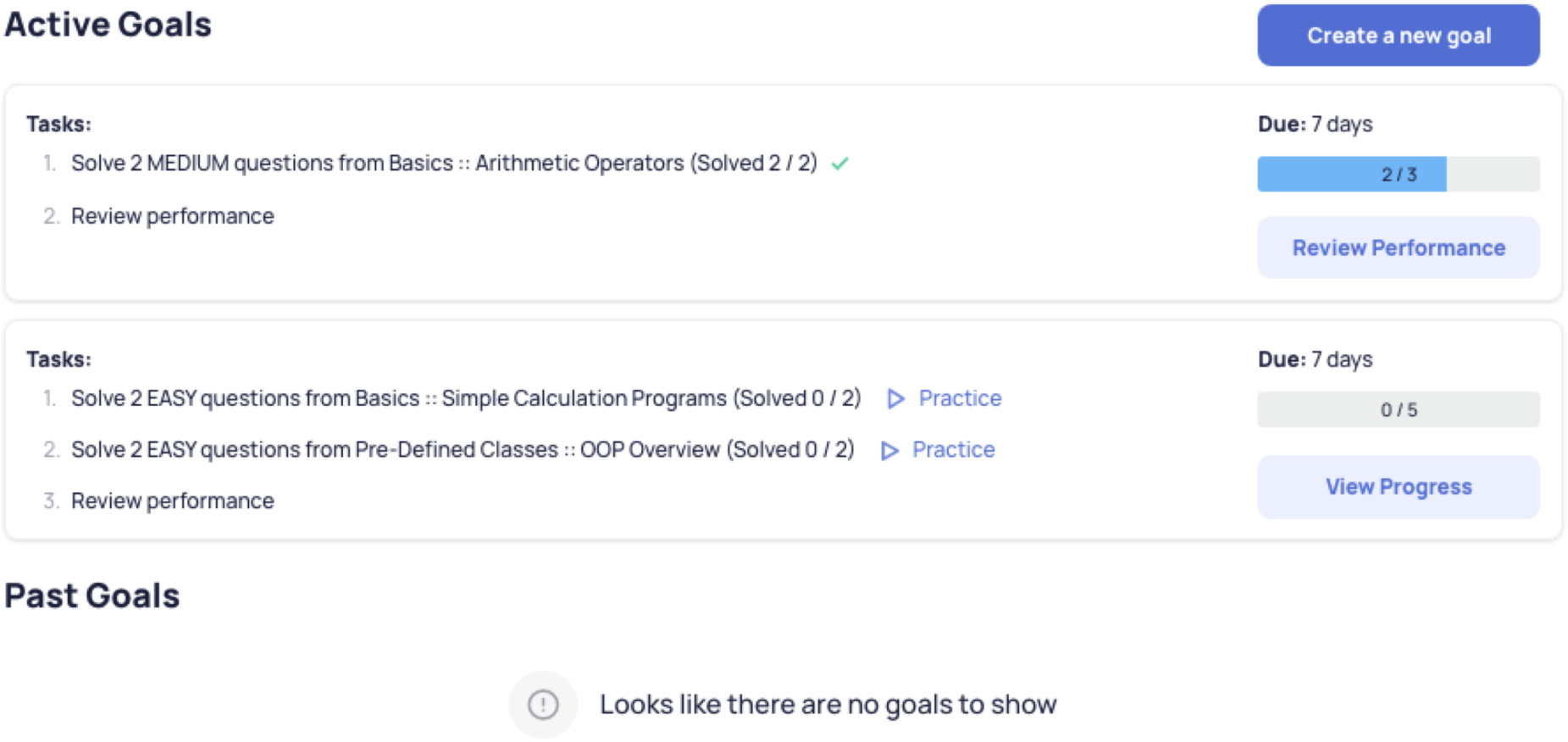
- Encourages students to engage and reflect about their own learning



Setting Goals



Monitoring Progress



Reflecting on Performance

Goal Performance Review

Tasks:

1. Solve 2 MEDIUM questions from Basics :: Arithmetic Operators (Solved 2 / 2) ✓
2. Review performance ✓

Due: 7 days

3 / 3

Task 1

2 / 2

You have completed 2 out of 2 exercises in this task.

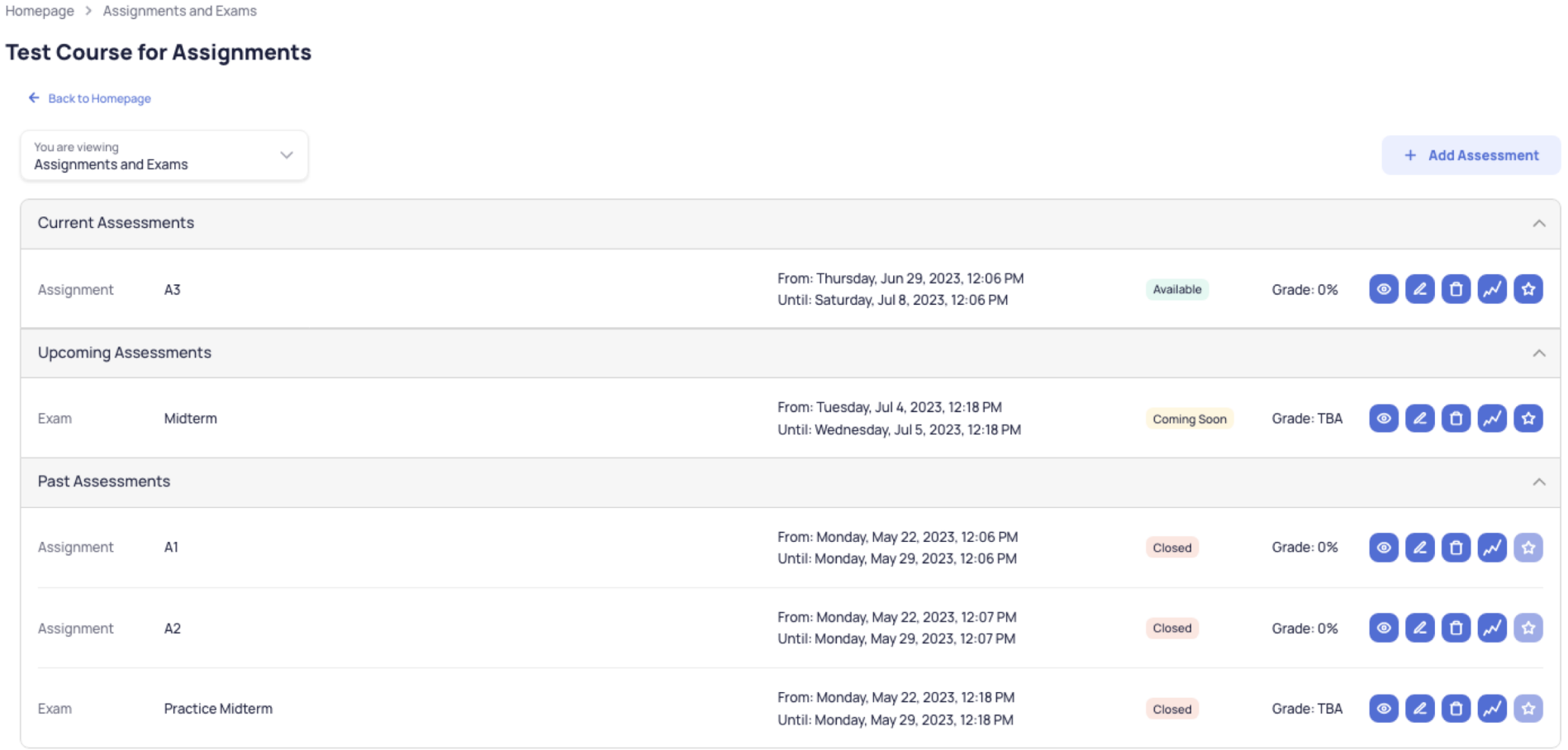
Question Stats

Question Type	Questions Attempt	Questions Solved	Success Rate
All	2	2	100% (↑ 100%)
Multiple Choice	2	2	100% (↑ 100%)

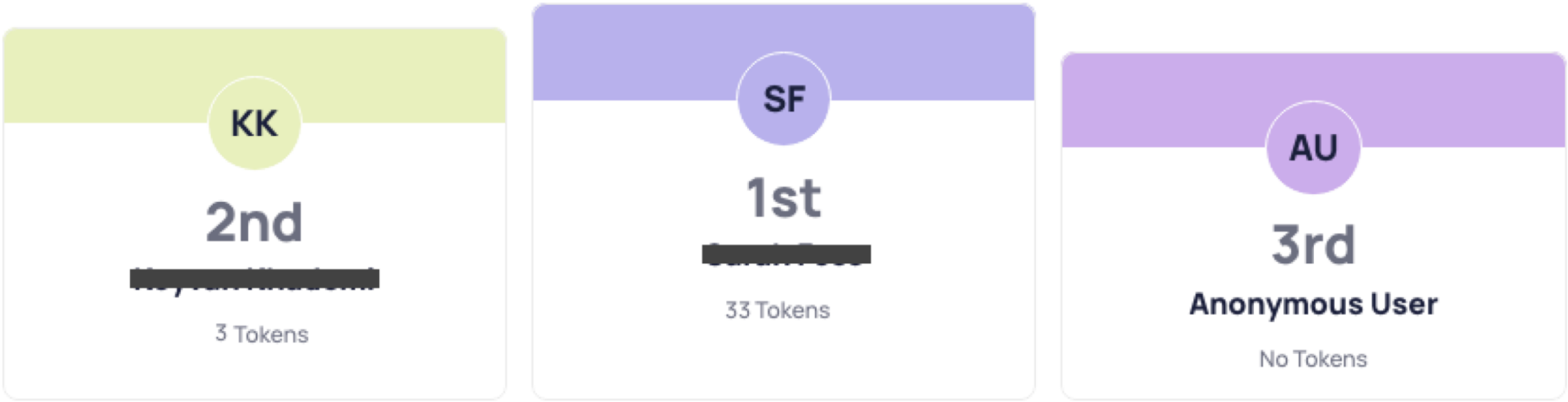
Practice Recommendations

You need to solve more questions in Basics :: Arithmetic Operators to improve your understanding of the topic. Practice is essential for mastering any subject.

Assignments and Exams

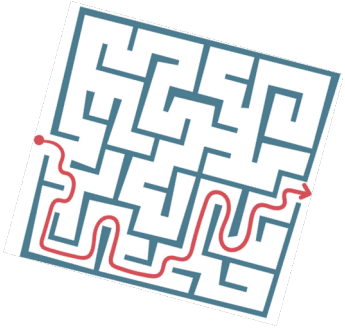


Leaderboard



Rank	Name	Tokens
4th	L [redacted]	No Tokens
5th	B [redacted]	No Tokens
6th	A Anonymous User	No Tokens

Challenges



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  - Users solve X questions in Y duration of time
  - Every team member receives tokens associated with those X questions
  - Goal: Incentivize students to do enough practice

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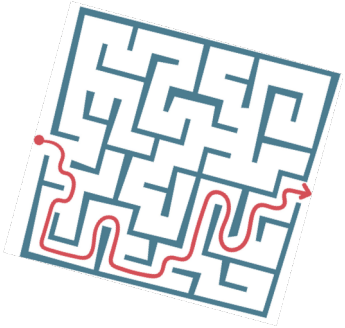

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  - Goal: Promote a deeper level of problem-solving by using fewer attempts

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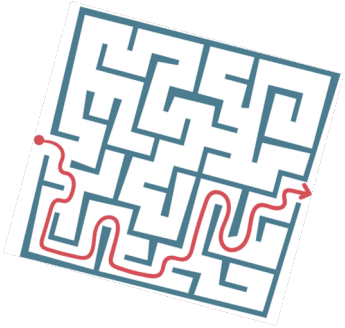

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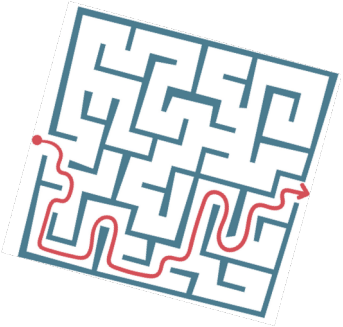

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- Student-created
  - Students create a challenge of one of the above types by defining parameters
  - Tokens awarded based on challenge type
  - Goal: Increase student's sense of ownership and make challenges more playful

Pilot Studies

- Since May 2022: Six CS1 classes with 650+ students
  - Generally positive feedback from students, instructors, and teaching assistants
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  - May 2003: students completed assignments with system
- Pilot study in January 2003 with 85 students
  - Self-regulated learning:
    - Pre-course survey showed students engage in goal setting
    - No system activity on goal planning-execution-reflection cycle
  - Gamification features:
    - Leaderboard usage showed novelty effect
    - About half the usage for challenges
    - Fewer female students, stopped after midterm #1

Summary and Future Work

- Course Gamification:
  - Open gamification platform for CS1 Java programming
- Next steps:
  - Continue to pilot at UBC this coming year
  - Analyze collected data
- Interested?
  - Seeking collaborators
  - Piloting at other institutions https://gamification.ok.ubc.ca/
  - Contact: Dr. Bowen Hui bowen.hui@ubc.ca