

# Immediate Feedback Collaborative Code Tracing

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## ABSTRACT

The Immediate-Feedback Collaborative Assessment Tool (IFCAT) is a web-based application originally designed to replace scratch-card based immediate feedback multiple choice quizzes. In this work, we detail IFCAT's code tracing ability, which allows for line-by-line immediate feedback of code tracing questions. This allows for scaffolded questions whereby subsequent questions on a test build upon previous results, without the danger of cascading errors caused by small mistakes. IFCAT also allows for think-pair-share and driver-passenger based collaborative assessment, and can be used on mobile devices for easy classroom integration.

## CCS CONCEPTS

• **Social and professional topics** → **Computing education; Computer science education; CS1.**

## KEYWORDS

CS1, code tracing, collaboration, think-pair-share

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## 1 BACKGROUND

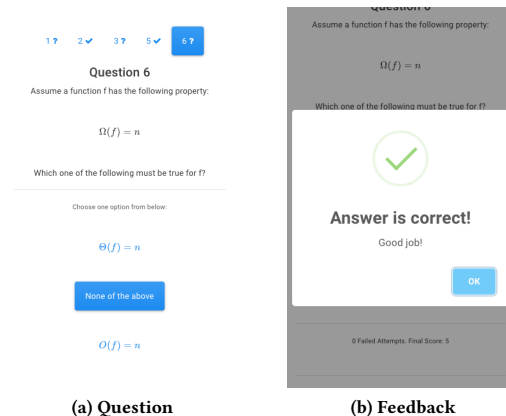
Most assessment techniques do not provide immediate affirmative feedback nor help students with retention of the course material. IF-AT is a multiple-choice based assessment system that helps with this issue. Students use scratch based answer tickets, and are instructed to scratch off the answer box that they think is correct, if a star is revealed, then the answer is correct. Individual question scores are calculated based on the number of boxes scratched (i.e. the number of attempts). Epstein Et Al.[1] showed that students tested using IF-AT had greater material retention rates.

Think-Pair-Share (TPS) is a popular collaboration model, wherein students first attempt to answer questions individually, then each student brings their answer to the group for discussion and eventual submission of a single group answer. TPS has been shown to

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(a) Question (b) Feedback

Figure 1: Multiple Choice Question

be very effective in computer science courses at both introductory and advanced levels[4, 6].

It is widely accepted that there is a "learning hierarchy" in computer science education. In general, students must master the skill of tracing code before they can start writing code [5]. Research has shown that CS1 students will generally acquire tracing skills before writing skills, and that the former provides a foundation for the latter, and effect that is temporary and normally diminishes by CS2 level courses[3].

## 2 IFCAT FEATURES

IFCAT is a web-based assessment tool designed for in-class tests and quizzes. It is accessible from any internet connected device, and is designed to be easily and effectively accessed from mobile devices.

### 2.1 Immediate Feedback

IFCAT supports classic multiple-choice and short-answer questions. With these types of questions, students are presented with a simple interface where they can choose/type their answer as shown in Figure 1. Upon submission, students will see a popup showing whether or not their answer is correct. If the answer is incorrect, they will be allowed to make an additional attempt for a reduced number of points. Additional question sub-types are available, including multiple answer, answer ranking, punctuation independent short answer, and edit distance based proximity short answer. Instructors can control the number of points per question, penalty for repeated errors, and number of allowed attempts.

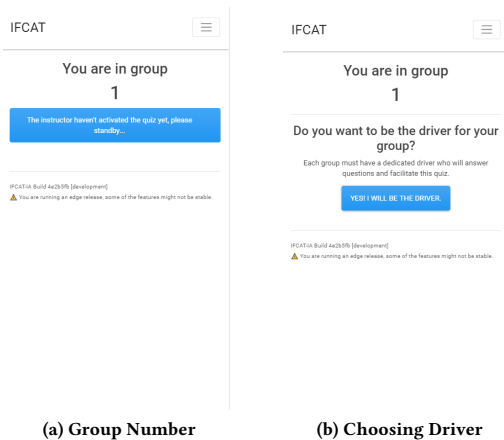


Figure 2: Group Collaboration

## 2.2 Collaboration

Using mobile devices provides a unique opportunity for group quizzes inside a classroom. Instructors can manually create groups, do random group assignments, or allow students to choose their own groups. In group self-selection mode, students can either start a new group, or join an existing group given the code from another group member.

As seen in Figure 2, once students join a group, they first choose a "driver" who will submit all answers for the group. All group members are still able to participate, and the driver will see the answers given by other members of the team, allowing them to "vote", but only the driver will be able to submit. Consensus mode is also available where all team members must agree on an answer in order to submit.

Students can also award "teaching points" to other group members after completing the quiz, it allows groups to recognize students that contributed the most during the quiz session. These teaching points can be automatically assigned to the TrAcademic classroom gamification system[2].

Think-Pair-Share mode allows for a combination of solo and collaborative modes, where students complete the same quiz first on their own, and then as a group, with the final score being an instructor defined ratio between the two components.

## 2.3 Code-Tracing

IFCAT treats code tracing similarly to a series of short answer questions, where each line (or other instructor defined unit) of output is submitted and verified. This allows instructors to build scaffolded questions where subsequent lines of output build on previous lines, without the worry that a small mistake or misunderstanding by students will cause cascading errors through multiple lines.

## 3 RESEARCH & FUTURE WORK

We are currently conducting a research project at the University of Toronto Scarborough to track usage and interaction of IFCAT

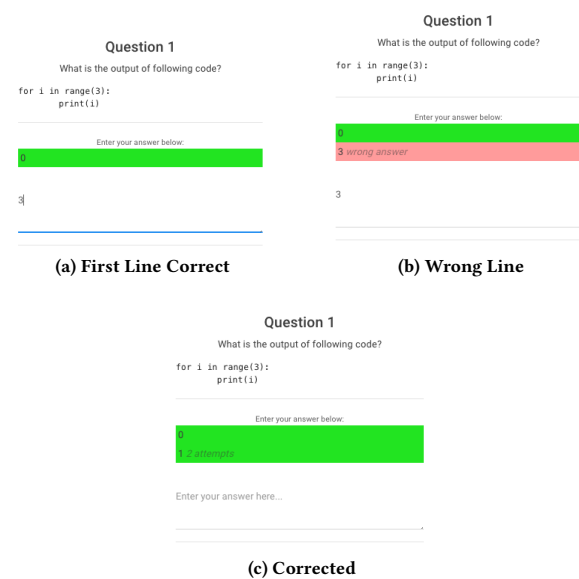


Figure 3: Code Tracing

among introductory CS students. Volunteers will be randomly assigned to subgroups to complete practice tracing questions throughout the term. The control group will use IFCAT without either immediate feedback or collaboration. One group will be assigned IFCAT with immediate feedback, and another with think-pair-share collaboration. A final group will be provided with the fully functional IFCAT tool using both immediate feedback and think-pair-share collaboration. We will then monitor each group in terms of satisfaction, tool usage, immediate learning gains (as measured by exit tests), and long term learning gains (as measured by course performance).

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