Figure 2. Views of Alice interface with and without a Stencils-based tutorial.

that allow users to see their mistakes as they occur. Alice allows students to gain experience with a number of programming concepts, including looping, conditionals, methods, parameters, variables, arrays, and recursion.

The mechanical supports Alice provides can help broaden the pool of computer science majors. A 2004 study found that using Alice 2.0 increases the academic success and retention of at-risk college students—freshmen intending to major in computer science who enter college with no programming experience and/or are not prepared to enroll in calculus as freshmen [4].

STORYTELLING ALICE

No matter how easy doing something may be, most people still need a reason to want to do it. While making the process of learning to program less needlessly frustrating may help retain students already interested in computer science, it is not sufficient for attracting new students into the field. Storytelling Alice introduces computer programming to middle school girls as a means to the end of creating animated movies [4]. From here forward, we refer to Alice 2.0 as "Generic Alice" and the version of Alice we modified to better support storytelling as "Storytelling Alice" (see the table here).

More than 200 middle school girls (most were Girl Scouts, ages 11 to 15, from the greater Pittsburgh area) participated in the formative evaluation that informed the design of Storytelling Alice (see Figure 1). Over 18 months in 2004 to 2005, we created and tested 15 different versions of Storytelling Alice. In trying to improve it, we were guided by the girls' storyboards of what they wanted to build, observed problems and listened to questions that came up during user testing, and recorded logs of the actions users took interacting with Storytelling Alice.

Based on this testing, we made three major changes to the Alice system:

Added high-level animations and support for creating multiple scenes. By analyzing the storyboards the girls created, we identified a set of high-level animations that would enable them to make better progress on their stories while providing natural motivation to use such programming constructs as methods, loops, and parameters;

Created a library of 3D characters and scenery that helps spark story ideas. One determining factor in girls' motivation to learn to program in Storytelling Alice is whether or not they have a story they want to tell. We found that the library of 3D characters with custom animation (such as a robot character with an animation called "crazy go nuts") inspired stories with topics ranging from too much parental pressure to romantic relationships gone awry that culminated with the robot going crazy; and

Created a story-based tutorial we present through a new interaction technique we developed called "Stencils." The Stencils-based tutorial is spatially overlaid on top

Storytelling Alice	Generic Alice
Say, think	Move
Play sound	Turn
Walk to, walk offscreen, walk	Roll
Move	Resize
Sit on, lie on	Play sound
Kneel	Move to
Fall down	Move toward
Stand up	Move away from
Straighten	Orient to
Look at, Look	Point at
Turn to face, turn away from	Set point of view to
Turn	Set pose
Touch, Keep Touching	Move at speed, turn at speed, roll at speed

Animations in Storytelling and Generic Alice compared.