

# Clover: Connecting Technology and Character Education Using Personally-Constructed Animated Vignettes

Brian P. Bailey\*, Sharon Y. Tettegah, and Terry J. Bradley\*  
Department of Computer Science\* and Curriculum and Instruction  
University of Illinois – Urbana  
Urbana, IL 61801

## ABSTRACT

K-12 schools need effective methods for delivering technology and character education. In this paper, we describe the iterative design, use, and evaluation of a tool that enables kids to construct animated vignettes expressing personal experiences. By building, sharing, and responding to vignettes, kids become engaged in reflection and problem solving moral and social issues, activities that build character. By creating their own vignettes, kids are able to acquire and apply technology skills within a learning activity meaningful to them. Evaluations of our tool were conducted with both teachers and kids. Results showed that all users were able to build meaningful vignettes, our tool was easy to learn and fun to use, and our tool's multimedia features were often used and well-liked, facilitating the creation of vignettes not possible with paper. Others can download and use our tool and draw upon our design rationale, results, and lessons learned when building similar tools.

## Categories and Subject Descriptors

K.3.1 [Computer and Education]: Computer Uses in Education – *Computer-assisted instruction (CAI)*, H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems – *Animations, Audio input/output*

## General Terms

Design, Human Factors, Experimentation

## Keywords

Animation, Multimedia, Storytelling, Vignettes

## 1. INTRODUCTION

K-12 schools need effective methods for delivering technology and character education [37]. In general, technology education is needed to help meet the rapidly growing demands of the IT workforce [15] and to ensure that kids are able to equally access and participate in an increasingly digital society [33]. However, a practical challenge for teachers is integrating the use of computers into learning activities that are meaningful to kids [22].

Character education is needed to improve core ethical values such as honesty, respect, and fairness among kids [8]. In particular, it is

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needed to help address the alarming rates of bullying and peer victimization that pervade K-12 schools [3]. Our work targets kids in upper elementary and middle school (grades 5-8) because they are at the most formative years of character development [36].

An effective method for character education is the use of vignettes that express moral or social situations as narratives [20, 36]. More recently, researchers have advocated the use of *animated* vignettes to better express the given situation [37]. Despite their increased learning potential, schools are unable to use animated vignettes because having them developed is overly expensive and, if created by adults, may not adequately reflect the experiences of kids [20].

In this paper, we describe the iterative design, use, and evaluation of Clover, a multimedia tool that empowers kids to construct their own animated vignettes expressing their personal experiences, as shown in Figure 1. The name Clover symbolizes the four parts of building a vignette – narrative, script, storyboard, and animation. Our tool provides an age-appropriate interface that leads kids through the process of constructing a vignette; writing a narrative and script, sketching characters and scenes, and animating scenes.

If vignettes are exchanged, our tool also allows kids to extend the animated narrative to describe how they would respond if in that situation, supporting existing teaching practices [37]. By building vignettes expressing their own personal experiences, responding to other kids' vignettes, and related discussion, kids are actively engaged in reflection, role-playing, and problem solving moral and social issues [36], activities that help build character [20, 21].

By using our tool to construct vignettes, kids are able to acquire and practice technology skills. Also, as recommended in [1], kids

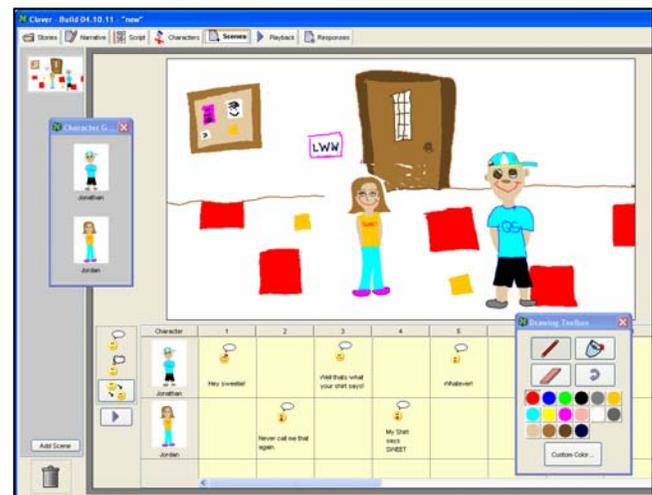


Figure 1: An animated vignette constructed by a 6<sup>th</sup> grader in our evaluation. Similar vignettes were created by other users.

are exposed to a few basic concepts about computing such as programming. But our work enables this learning to occur within an activity *meaningful* to kids – expressing personal experiences.

Evaluations were conducted with both teachers and kids. Results showed that all users were able to successfully use each part of our tool to build meaningful vignettes, teachers believed our tool would be very useful for technology and character education, kids found it easy to learn and fun to use, and the multimedia features were often used and well-liked, facilitating creation of vignettes that would not be possible if using just pencil and paper alone.

The contributions of this work are (i) an age-appropriate tool that allows kids to build, share, and use their own animated vignettes, enabling these types of vignettes to be widely used; (ii) design rationale, empirical results, and lessons learned that others may draw upon when developing similar multimedia tools; and (iii) applying research in multimedia design to a real-world problem, resulting in a practical tool that enables the use of multimedia for character education, enhancing kids' learning experiences.

## 2. RELATED WORK

We discuss the rapidly growing need for technology and character education, the benefits of using vignettes as teaching tools, and how our vignette design tool differs from other storytelling tools.

### 2.1 The Need for Technology & Character Ed

Technology education refers to attaining technology literacy skills such as keyboarding, media, and Web skills, and an understanding of basic concepts about computing such as control, algorithms and programming [1]. Technology education is needed to ensure that kids (on into adulthood) are able to equally access and participate in an increasingly digital society [33]. It is also needed to meet the rapidly growing demands of the future technology workforce [15]. However, kids, especially in upper elementary and middle school, rarely work with or learn about technology in the classroom, in part because teachers are unable to integrate computing within learning activities that are meaningful to kids [13, 22].

Meanwhile, there is a rapidly growing demand in the U.S. and elsewhere for schools to deliver effective character education [8], which refers to teaching ethical values such as caring, honesty, respect, fairness, and tolerance. Effective character education has been strongly argued and empirically shown to improve ethical thinking and social behavior among children [16, 20, 36].

In particular, character education is needed to help address the alarming rates of bullying in K-12 schools [3]. Studies show that 10% of students report being bullied often [24] while 75% report being bullied at least once [14]. Rates peak as kids shift from elementary to middle school [41]. Bullying has consequences for victims, e.g., depression, lower self-esteem, and anxiety [28], and for bullies, e.g., theft, drinking alcohol, and school drop-out [21].

Our work *connects* technology and character education through animated vignettes. By enabling kids to use technology to build vignettes expressing personal experiences, they are able to acquire and practice technology skills and learn about computing concepts within a learning activity that is meaningful to them. Educators can then use the outcomes of that process – the vignettes – to deliver character education. Our work is meant to be integrated into broader programs on character and technology education.

### 2.2 Vignettes as Teaching Tools

A vignette is a situation expressed in a narrative or dialogue form [39]. Vignettes are effective teaching tools because they provide representations of teachable situations, allowing kids to think critically about those situations while being removed from them. Vignettes produce a more involved and voluntary educational process than traditional texts [39] and provide an instrument for assessing attitudes and behaviors [40]. Vignettes have been used to teach mathematics and science [9], management skills [32], problem solving [10], and character education [16, 20, 36].

For character education, vignettes are typically used to facilitate role-playing, problem solving, and discussion related to moral and social issues [11, 35, 36]. These techniques have been shown to build character (ethical thinking and behavior) among kids [16].

We extend the use of vignettes for character education in three ways. First, our work uses *animated* vignettes, as they provide a more realistic representation of moral and social experiences [37], allowing viewers to better identify with the depicted experiences. Second, consistent with recommendations in [20, 36], our work uses vignettes that are based on *personal* experiences rather than on artificially constructed situations. This allows kids to become more engaged in their own moral and social thinking [20, 35, 36].

Finally, we developed a computer-based tool (focus of this paper) that allows kids to construct their own animated vignettes and that supports related pedagogical practices. While schools could hire designers to build animated vignettes from kids' text narratives, this is overly expensive and creates an opportunity loss for kids to build their own vignettes using an appropriate computer tool. Our tool enables the use of animated vignettes on a large scale.

### 2.3 Computational Tools for Storytelling

Many computational storytelling tools have been developed for kids. KidPad allows kids to draw on a zooming canvas and uses spatial hyperlinks to support non-linear stories [12]. The tool was later extended to support collaborative [4] and tangible input [34].

Kaleidostories is a web-based tool that encourages kids to actively explore their identity and their moral and social values [6]. The tool provides visual awareness of others who share similar values to foster collaboration and communication. Similarly, Zora offers a 3-D environment for exploring identity and moral values [5].

KidsRoom is a physical playroom that immerses children in an interactive adventure story [7]. Children interact with virtual characters and physical objects to become part of the story itself. Extending these concepts, the StoryRoom allows kids to construct their own parts of the playroom as well their own stories [19].

KidSim allows kids to construct their own story-based simulations using graphical rewrite rules and programming by demonstration [30, 31]. Sharing similar learning goals, many other programming tools and computational objects have been created to allow kids to explore and learn about computational behavior, e.g., [23, 25].

Our work on Clover differs from existing tools for storytelling and simulation because (i) it supports the *process* of constructing vignettes, including writing narratives, sketching characters and scenes, and animating scenes, (ii) it supports related educational practices such as creating responses, (iii) it is used for expressing personal experiences rather than imagination-based stories, and (iv) the resulting vignettes are used to deliver character education.

### 3. GOALS AND ITERATIVE DESIGN

To establish goals for an effective vignette design tool and the broader project, we worked with teachers and other educational experts, drew upon lessons from related storytelling tools (e.g. [5, 12, 23, 31]), and leveraged the second author’s many years of research and practical experience with technology and character education. From these sources, we identified the following goals:

- *Develop an interface appropriate for kids in grades 5-8.* Kids in upper elementary and middle school (grades 5-8) are at formative stages of character development [36], as they are just beginning to experience and take responsibility for their moral and social choices [20]. Thus, this is when character education could have the most impact [29]. Since kids at this age are between childhood and adulthood, we felt that an adult-oriented interface could be effective if it were given a softened, more inviting look, e.g., using larger buttons, more color and icons, rounded corners, less formal fonts, etc. We also wanted most of the interaction to be immediately visible, not hidden in menus or dialogs. This would give the tool a less formal feel, while lowering the learning curve and restraining the design temptation to add more function than necessary.
- *Employ constructivist theories of learning.* Constructivist learning theory argues that kids learn best by doing – creating, building, and modifying their own learning artifacts [23]. Although a constructionist approach has been applied to many computational learning tools (e.g., [5, 25, 31]), we wanted to apply this approach to encourage kids to construct their own animated vignettes for character education. An effective tool should support the entire process of constructing a vignette – writing a narrative and script, sketching characters and scenes, and animating the story. It should also enable non-linear and iterative construction and result in reusable learning artifacts.
- *Enable kids to express their personal experiences better than if using just static media alone.* A student can easily write about and illustrate a personal experience using pencil and paper. Thus, an effective computer-based tool should enable and encourage kids to construct representations of their personal experiences that are richer and more compelling than those that could be created with just pencil and paper. In particular, we wanted users to be able to build *animated vignettes*, e.g., where dialog can be sequenced and characters can have real voices. Enabling kids to better express a personal experience should help them become more vested in the learning process, improving learning outcomes [23].
- *Deliver technology education through the construction of the vignettes.* Technology education refers not only to developing literacy skills such as keyboarding, media, and Web skills, but also to learning concepts *about* computing such as sequential flow, algorithms, and programming [1, 25, 26]. By using our tool to construct vignettes, we wanted kids to gain both forms of technology education. In particular, we wanted to design interface representations that expose kids to basic concepts, but that are meaningful within the broader learning context. These are known as analogical representations [30]. In our project, we wanted to enable kids to learn about and use technology, but we wanted the learning emphasis to be on *constructing the vignettes*, not on the technology itself.

- *Facilitate delivery of character education through animated vignettes and support related educational practices.* By expressing personal experiences in the form of animated vignettes, kids become engaged in introspection and reflection about their own moral and social thinking [11, 35, 36]. The resulting vignettes then serve as a basis for role-playing, problem solving, and discussion. For example, a common practice is for a student to view a vignette created by another student, assume the perspective of one of the characters in it, and write a response describing how s/he would react if in that same situation [37, 38]. Using the vignettes and responses, teachers then discuss appropriate behaviors for the depicted situation. An effective vignette design tool must support this educational practice of creating and responding to vignettes.
- *Connect the delivery of technology and character education through the process of constructing and using vignettes.* An effective tool should facilitate integration of technology and character education, creating a unified pedagogical experience more effective than its component parts. By having kids construct vignettes based on their personal experiences, they become more vested in the learning activity since the outcome is more meaningful to them [2, 37]. Kids should thus strive to understand how to use a computer tool to more fully express those experiences [23]. Also, since a computer-based tool can enable better expression of personal experiences than paper, the resulting vignettes should have greater meaning to its author and greater learning impact on its viewers.

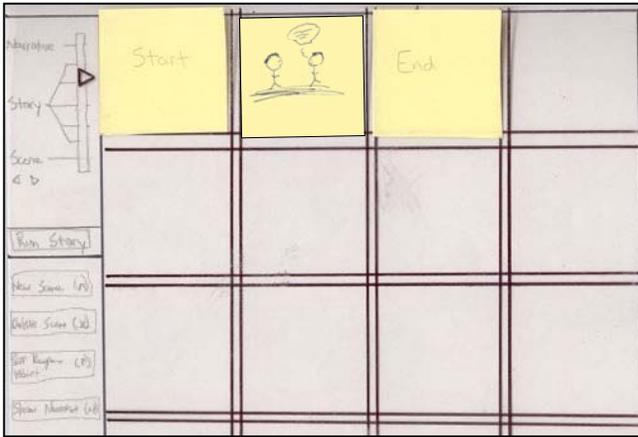
Although these goals are not exhaustive, we felt that they would most influence the development of our vignette design tool. Also, while the current implementation of our design tool may not fully support each of these goals, we felt that it was very important to define them up front in order to guide later design decisions.

Developing a computational tool that supports the entire process of constructing and responding to animated vignettes while being easy to learn and fun to use for kids presents a significant design challenge. To address it, we followed an iterative design process [27]. We performed a user and task analysis, and then iteratively developed and evaluated prototypes to support those tasks [27].

#### 3.1 User and Task Analysis

Our first step in the design process was to perform a user and task analysis. Target users were kids in upper elementary and middle school (grades 5-8). From working with kids in local schools, our analysis showed that they are typically familiar with instant messaging, word processing, interactive games, Web browsing, and more, but we recognize that wide variance exists [33]. Our goal was to better understand the allowable scope of the tool’s complexity. For example, our analysis strongly discouraged the use of a text-based programming language in our tool since most of the kids had little or no experience with one. Teachers were also target users – unless they are able to understand and use our tool, they would not be able to deploy it in a classroom.

A task analysis was performed to enumerate the core user tasks for our tool, including creating a new vignette, writing a narrative and script, sketching characters and scenes, animating scenes, and responding to existing vignettes. Each task was described in the form of a user scenario, a narrative describing how a user would accomplish the task independent of any particular interface [17].



**Figure 2a:** An early prototype showing the interface screen for managing scenes. This prototype used zooming to allow a scene (rectangular area) to be edited at multiple levels of detail.

Scenarios were evaluated with educators and refined based on their feedback. This process continued until the educators found our scenarios to be consistent with their teaching practices. For example, we learned that educators want to use templates to guide kids when writing narratives, make written comments at various steps when building a vignette, integrate vignettes with a web site, have multiple kids create responses for the same vignette, and much more. The scenarios then fed into an iterative design phase.

### 3.2 Iterative Design

Our next step was to design prototypes and evaluate how well they supported our core tasks in an iterative process. Prototypes gradually progressed from low-fidelity paper prototypes to higher-fidelity functional prototypes. About six major design iterations were performed and each prototype was evaluated with 3-5 users.

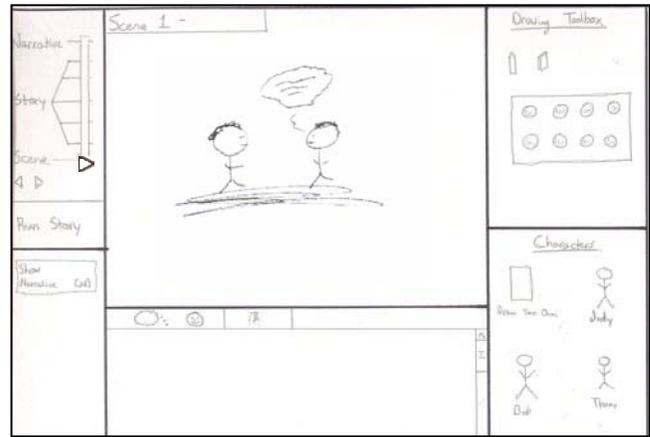
The benefit of iterative design is to enable rapid exploration of the design space with low investment [17], allowing design lessons to be identified *early* in the process where it is still cost effective to address them. For example, an early prototype (Figure 2a) used zooming to enable scenes to be edited at multiple levels of detail. But users felt this interface did not adequately reflect the discrete steps of building a vignette. We re-designed it to use a tabbed pane where each tab represents one step in the vignette process.

Another lesson was to separate character design from scene design (Figure 2b). Users felt that vignettes would be composed of multiple scenes with many of the same characters, causing them to think about character design separate from scene design. As a result, we re-designed the tool's interface to offer separate screens for creating characters and scenes. Subsequent evaluations found both of these design changes to be effective. These and other lessons were integrated into our final prototype called Clover.

## 4. CLOVER

Clover is a multimedia tool that empowers kids and teachers to construct their own animated vignettes that meaningfully express personal experiences. The name *Clover* is a symbol for the four parts of a vignette – narrative, script, storyboard, and animation.

As shown in Figure 3, Clover is comprised of interface screens connected in a tabbed pane for constructing a vignette. Selecting a tab moves to that step in the design process and provides interface actions appropriate for completing it. The tabs lead – they do not

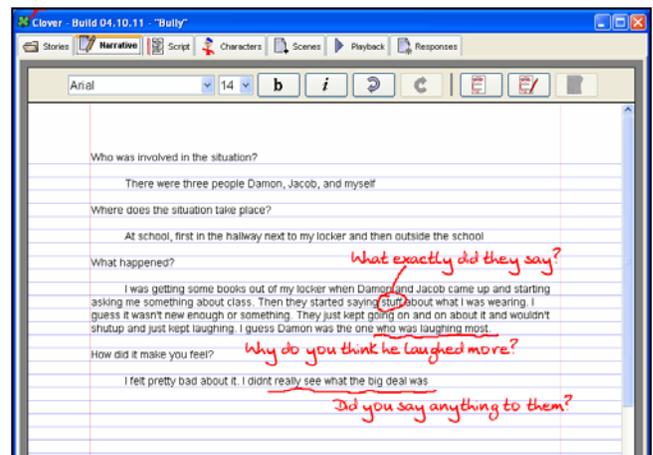


**Figure 2b:** An early prototype showing the interface screen for creating characters and scenes. A character was created by inserting a blank template and then painting within the bounds.

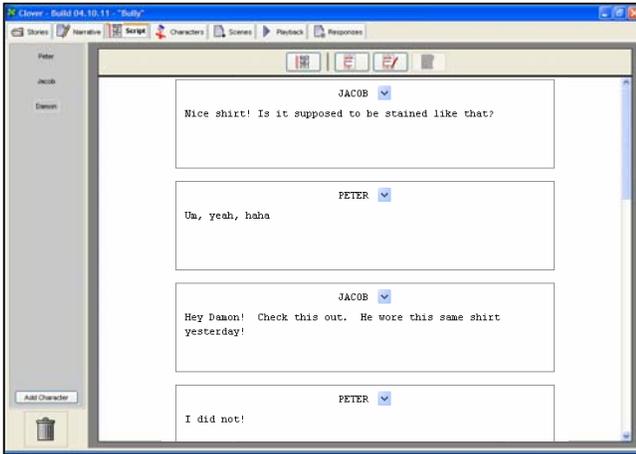
force – users through the vignette design process, allowing them to construct vignettes in a non-linear, iterative fashion. The tool works best with stylus input, e.g., using a tablet PC or inexpensive digitizing pad, but is compatible with a mouse input device.

In the next sections, we illustrate how Clover supports the process of constructing a vignette; writing a narrative, writing a script, sketching characters, sketching scenes, animating scenes, playing a vignette, and responding to a vignette. Figures accompanying these sections illustrate the construction of a particular animated vignette. A student (Peter) is expressing the experience of when two other students (Jacob and Damon) were teasing him about his clothes. This is a realistic situation representative of those that students face far too often [41]. But our tool can be used to express almost any moral issue, social issue, or other situation.

In practice, a teacher would ask kids to construct vignettes with a certain learning theme, e.g., tell me about a time when you had to decide between right and wrong. After creating the vignettes, kids would exchange them (among themselves or with another class), view them, write responses, and discuss them. Vignettes and responses also provide a rich instrument to *assess* character, e.g., how were characters drawn, what was drawn in scenes, how were characters sized in scenes, what was the content of the dialog, etc.



**Figure 3:** In the Narrative editor, Peter describes his experience in prose. A template can be configured (shown as questions) to help elicit parts of the story. The editor also supports annotation.



**Figure 4:** Using the Script editor, Peter refines his narrative into a specific sequence of dialog among the characters. The editor allows lines to be added, edited, and re-arranged.

#### 4.1 Writing a Narrative

The Narrative editor enables kids to write about an experience in prose, facilitating practice of language arts and keyboarding skills. As shown in Figure 3, the editor supports the use of various fonts, styles and sizes, as well as undo and redo of editing actions.

To elicit a story or to help kids better organize their thoughts, a template can be defined that appears when the narrative editor is first opened. For example, a template could simply ask questions about the experience such as when and where it occurred, who was involved, what were you doing, and what happened [36]. The template used would reflect the particular theme of the vignette.

The editor supports a comment feature, allowing a teacher (or kids who exchange vignettes) to review the narratives and add comments or other graphical marks. Kids can step through the comments and modify the narrative as needed. Each comment is placed into a separate layer that is rendered on top of the text.

#### 4.2 Writing a Script

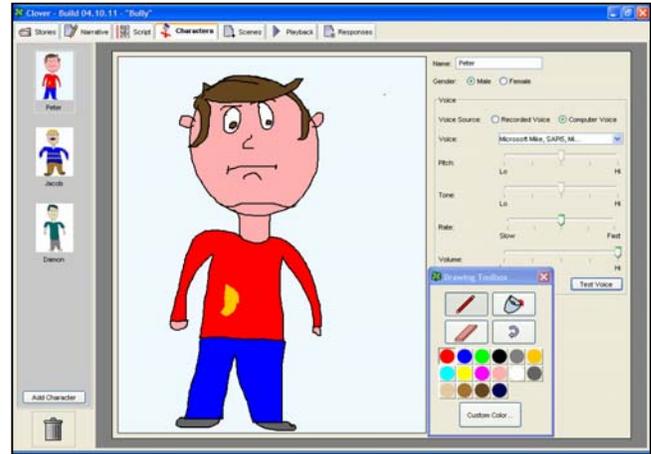
Once the narrative is written, a student uses the Script editor to explicitly define what people involved in the experience, referred to as *characters*, said and in what order. See Figure 4. Writing a script is an important part of constructing a vignette, as it causes users to think about the specific sequence of events in greater detail. The script helps a user better transition from writing the narrative in prose form to later creating animated scenes.

Writing a script in our tool is similar to writing a script, for example, for a movie, though not nearly as complex. To define a script, a student creates and names the characters. For each line that a character is to speak, the name of the character is dragged into the script editor and a blank box appears at the end of the current lines. Within the box, a student enters the character's line.

The script editor enables content of the lines, characters that speak the lines, and the temporal sequence of the lines to be edited. The editor supports the same comment feature as the Narrative editor.

#### 4.3 Sketching Characters

Selecting the Character tab opens the Character editor, shown in Figure 5. The editor provides a blank canvas and drawing toolbox. The toolbox offers drawing tools that currently include a pencil, paint bucket, eraser, color selection, and undo/redo actions.



**Figure 5:** Peter uses the Character editor to sketch the three characters in his story, which appear as thumbnails on the left. Character properties are set in the control panel on the right.

A student sketches characters from scratch and our tool does not provide pre-defined characters or other related objects. We made this decision in part to be consistent with constructivist theories of learning, but mostly because educators strongly argued that kids need to refine their own visual thinking and artistic skills.

To the right of the drawing canvas, properties of a character, such as name and gender, and whether the voice will be later recorded or should be generated with a text-to-speech engine. For the latter, options for the volume, pitch, tone, and rate can also be defined.

As characters are added, they appear as thumbnails to the left of the canvas. Any character can be edited by selecting its thumbnail. The drawing canvas is transparent so that when characters are later added to a scene, they always appear on top of scene content.

#### 4.4 Sketching Scenes

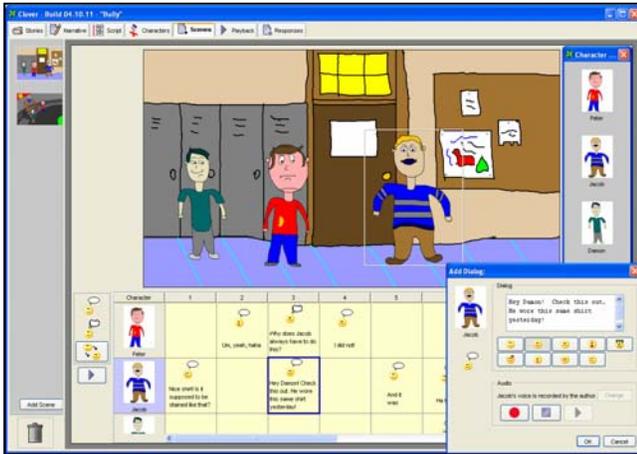
The next step is to sketch scenes and add characters to them using the Scene editor, shown in Figure 6. Consistent with the Character editor, the Scene editor offers a drawing canvas, drawing toolbox, and scene thumbnails to the left. A floating dialog shows available characters from which they can be dragged into any scene.

For reasons similar to those discussed in Section 4.3, pre-defined scene objects are not provided. A disadvantage is that kids will likely require more time to create scenes, while the advantage is that kids are able to refine their visual thinking and artistic skills. Further, the resulting scene reflects the student's actual visual interpretation of the experience, rather than reflecting how well the existing scene objects could be composed to approximate it.

A student uses the drawing tools to sketch content for any number of scenes. To insert a character, the desired thumbnail is dragged from the dialog, placed on the canvas, and sized as appropriate. Characters always appear on top of scene content. If a character is later edited in the Character editor, all instances of that character are updated in the scenes. The order (top to bottom) of the scenes on the left determines their temporal order during playback.

#### 4.5 Animating a Vignette

When a character is added to a scene, a thumbnail is added to the Action Grid below the canvas, shown in the lower part of Figure 6. Each character occupies a row in the Action Grid. Similar to Director [18], the Action Grid is an editable timeline of the



**Figure 6:** Using the scene editor, Peter sketches two scenes and adds characters to them. The Action Grid is in the lower frame and is used to animate dialog among characters. For example, to add speech for Jacob's character, Peter drags a Speech action to the corresponding row in the grid (second row above). A dialog appears (lower right) allowing him to enter the text and select an emoticon to add specific emphasis. Peter can also record himself speaking the text using controls near the bottom of the dialog.

behavior of a scene. But unlike Director, the Action Grid directly supports addition of speech and thought actions for characters. In the Action Grid, time moves from left to right, each cell represents a single time step, and each column represents the same step for all characters. Visual inspection of the grid provides an immediate sense of the sequential and parallel behavior of the vignette.

A visual language for the Action Grid supports two categories of actions; Speech and Thought actions. A Speech action defines a particular line that a character speaks while a Thought action defines what a character is thinking at a particular moment. To add an action to a scene, the desired category of action is dragged to an empty cell in the Action Grid. The row in which the action is placed determines the character to which the action applies. Once placed, a dialog is displayed for entering relevant properties, including the text that a character should speak or is thinking and an emoticon that defines the appropriate emphasis. For Speech, if the 'record voice' option was selected for this character, then a student would record her voice (or solicit another student's voice) for the character saying the line. Additional programmatic actions could easily be added to our existing visual language, including actions for character motion, background music, iteration, etc.

The location of actions in the Action Grid defines sequential and parallel behavior among the characters. For example, by placing a Speech action for one character and a Thought action for another character in the same column, the actions execute in parallel at playback, thus showing what one character is thinking while the other is speaking. By manipulating actions in the grid, users are manipulating sequential and parallel execution of a system. To play the scene, a user selects the 'play' button shown in Figure 6.

#### 4.6 Playing a Vignette

To play the entire vignette, a student selects the Playback tab and the first scene begins playing, as shown in Figure 7. The system executes actions in the Action Grid from left to right. After executing the last action of a scene, the system moves to the next scene, and so forth until the last scene is played.



**Figure 7:** A frame of Peter's vignette at playback. Callouts show what characters are saying and thinking. When callouts appear depends on where the actions were placed in the Action Grid.

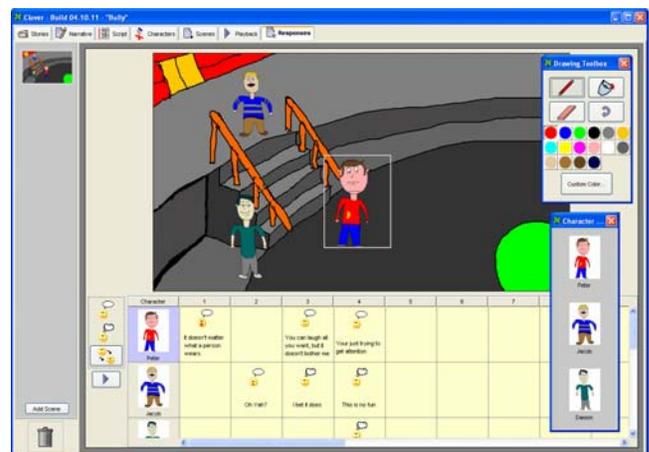
At playback, a Thought action is executed by adding a visual callout (with bubbles) that shows the text and assigned emoticon near the upper right of the character. A Speech action is executed by adding a callout (no bubbles) that shows the spoken text near the character, and playing the recorded audio or generating speech for that text. For generated speech, the emoticon is passed to the speech engine to affect the pitch and pace of the generated speech.

#### 4.7 Responding to a Vignette

Once built, vignettes can be exchanged. After viewing a vignette, a response can be created by extending the animated narrative focusing on what a particular character says or thinks. By creating responses, kids become engaged in problem solving moral and social issues, a fundamental part of character education [16, 36].

Shown in Figure 8, the Response editor is similar to the Scene editor, offering a drawing canvas, drawing toolbox, Action Grid, and characters. Any number of responses can be created, but in our current version, a response may consist of only a single scene.

The Response editor is seeded with a copy of the last scene and characters from the vignette. A different scene could be created by erasing and redrawing the content. Responses are shown to the



**Figure 8:** The Response editor allows users to extend Peter's vignette, showing how they would respond if in that situation. It is seeded with the last scene and characters from Peter's vignette.

left of the canvas. After playing a vignette, a dialog appears from which existing responses can be selected and played, showing how different users would handle that same situation. Future work is to allow a response to include multiple scenes and include permissions to ensure users can modify only their own responses.

Vignettes and responses can be uploaded to a publicly accessible web site (URL removed for review), resulting in reusable learning experiences. This lowers the barrier for others to leverage the use of vignettes (and our tool) for character and technology education.

## 5. IMPLEMENTATION

Clover was implemented to facilitate broad deployment. The tool was programmed in Java due to its portability and consists of about 13,000 lines of code spanning 60 classes. Java Sound is used to record and playback audio while Java Speech coupled with Microsoft SAPI is used for text-to-speech synthesis. To add emotion to the speech generation, the text is marked up using the Java Speech Markup Language before being passed to the speech engine. For example, text for a Speech action with an angry emoticon would have tags indicating a faster rate and higher pitch.

Clover executes on almost any modern PC machine and is best used with stylus input. Stylus input could be made available by executing our tool on a Tablet PC or connecting an inexpensive digitizing pad to any desktop machine. If access to a stylus is not possible, Clover is compatible with a standard mouse device. The prototype described in this paper is completely functional and can be downloaded from (URL removed for blind review).

A limitation of our current implementation is that it does not have a model of a character’s joints for realistic animation or mouth for precise lip synchronization during speech playback. Several users pointed out these limitations in our evaluations. Future iterations of the tool will explore solutions to these limitations.

## 6. EVALUATION

We conducted two user evaluations of Clover – one with middle school teachers and another with kids in grades 5-8. The purpose was to evaluate how well users could use various parts of our tool for constructing vignettes, to identify critical usability issues, and to gain high-level feedback about using our tool as part of a broader program on character and technology education.

### 6.1 Procedure

The evaluation with teachers (N=10) was conducted in a local middle school as part of their annual professional training. The evaluation with kids (N=10, 6 girls) was conducted in a large conference room at our University and each student was provided with a Tablet PC. Each student was between 10 and 13 years of age (average was 11), and attended various local schools. Both evaluations followed the same basic procedure.

After discussing specific goals of our project, we provided a brief introduction to our tool, giving only about a one minute overview of each interface screen. We wanted users to explore and figure out how to use the tool on their own. We encouraged questions and multiple experimenters were available for quick responses.

Users were asked to recall a recent personal experience and use our tool to express it as realistically as possible. Users worked through the entire vignette design process – writing narratives and scripts, sketching characters and scenes, and animating scenes. Given time constraints, responses were not created. Users worked

on vignettes for about 45 minutes, completed a questionnaire, and participated in a group discussion about the use of the tool.

## 6.2 Results

Since results from the teachers and kids were very similar, we discuss them collectively and note differences when appropriate.

All of the users were able to successfully use each part of the tool (within time constraints) for constructing their vignettes. Vignette content involved mostly social experiences, including interactions in the hall, in the classroom, on the basketball court, on the bus, and the playground. This further shows that personal experiences are naturally communicated as stories [36] and explains why they are such a powerful catalyst for character education – kids can better identify with other kids’ personal experiences.

Figure 1 showed the vignette that a 6<sup>th</sup> grader created with our tool, which is similar to the vignettes created by the other users. With the tool being used for only 45 minutes, vignettes consisted of about a half to full page of narrative text, five to seven lines in the script, two to three characters, one to two scenes, and about three to five speech or thought actions in the action grid. This shows that users were able to effectively use each part of our tool, and with minimal instruction. Users noted that while they were able to express the breadth of their story, they needed more time to capture details. This suggests that, in practice, teachers may want to split the construction of vignettes into multiple sessions.

Vignettes were constructed in an iterative and non-linear process, e.g., a user would edit part of a scene, then refine the narrative and characters, and then continue editing the scene. This confirms our design rationale not to force users through the process, but allow them to see all of the steps and navigate freely among them.

**Table 1: Teacher and Student Ratings (Mean, S.D.)**

Questions about Clover	Teacher Ratings	Student Ratings
The narrative interface was easy to use	6.1, 0.6	6.6, 0.5
The script interface was easy to use	5.9, 0.6	5.1, 1.4
The scene interface was easy to use	4.9, 1.6	5.4, 1.6
The animation interface was easy to use	4.9, 1.5	5.1, 1.6
The tool was easy to learn and use overall	5.0, 1.2	6.0, 1.3
I could teach someone else how to use it	4.9, 1.4	6.1, 1.2
The tool provides an interface that is appropriate for kids in grades 5-9	5.6, 1.1	6.0, 0.7
Constructing stories with this tool is more compelling (fun) than just using paper	6.4, .91	5.9, 1.5
I would enjoy constructing and sharing my stories to develop stronger character	N/A	6.0, 1.0
I would enjoy constructing stories using computers to learn more about them	N/A	6.6, 0.7
I would enjoy constructing stories that deal with my own experiences more than constructing pretend stories	N/A	5.5, 1.6
The tool would be useful as part of a program to deliver character education	6.1, 1.2	N/A
The tool would be useful as part of a program to deliver technology education	6.3, 1.2	N/A
The tool supports my own pedagogical practice of using stories in the classroom	5.6, 1.3	N/A

User ratings from the questionnaire were extremely positive, see Table 1. Ratings of agreement with the statements in the table were performed on a 7-point scale, which ranged from 1 (Strongly Disagree) to 7 (Strongly Agree). Results were very encouraging since this was the first time that any of these users had seen or used our tool. We attribute the high ratings to having iteratively developed numerous prototypes in the design process, and having collaborated closely with educators from the onset of the project.

In particular, teachers agreed that the vignettes created with our tool would be more compelling than those created with just paper ( $\mu=6.4$ ). They also felt that the tool would be useful as part of a broader program on character ( $\mu=6.1$ ) and technology ( $\mu=6.3$ ) education and would be supportive of related practices ( $\mu=5.6$ ). Various comments from the teachers about Clover included:

Creating your own vignette makes the experience much more personal. Clover is good because it is very engaging.

The stories can help children identify with one another.

It's fun. It doesn't seem like you are doing real work.

It is something that would be very "high interest" to children.

I liked the top menu bar in terms of it being a process and moving onto the next tab.

Clover would help kids understand narratives, the use of technology, and computer programming.

The vignettes allow for reflective and critical thinking.

Similarly, kids generally agreed that they would enjoy constructing stories using computers in order to learn more about computers ( $\mu=6.6$ ), that they would enjoy constructing stories from their own experiences more than constructing pretend stories ( $\mu=5.5$ ), that constructing stories with Clover is more fun than just using paper ( $\mu=5.9$ ), and that they would enjoy constructing and sharing personal experiences to help develop stronger character ( $\mu=6.0$ ). Various comments from kids about Clover included:

I thought that the first part where you told what the story was about and the drawing part was fun.

The scene part was very easy.

I thought drawing characters was fun.

I thought the narrative [was] pretty easy to understand. You would just type it in.

I think that the program was very easy to use.

Pretty much what to do and how to do it was easy.

Every part was pretty easy.

I thought recording my own voice was fun.

The use of Clover was not error-free, as we observed many usability issues. For example, users had difficulty understanding how to name characters, add lines, and organize lines in the Script editor. In the Character and Scene editors, a few users reached the edge of the canvas when drawing, but there was no function for moving the content to a different location. Users commented that they wanted lines from the script to be available for the speech and thought actions in the Action Grid as opposed to having to re-type them. Also, several users wanted to speak the lines in the Script editor as opposed to writing them. Users wanted the faces of characters to change given the emoticon added. These usability enhancements can be easily made in future iterations of the tool.

From observing users use Clover and from the group discussions, we learned several additional lessons about the tool. First, we

learned that both teachers and especially kids were emphatic about wanting to share the characters and scenes in their vignettes. We observed users often turning their screens to show or walking over to another's person's machine to view a vignette, consistent with lessons in [34]. This inspired users to go back and work even harder on their own vignettes. Allowing characters and scenes to be shared is very feasible, but future work should investigate how to properly balance this sharing with the desire for kids to apply and refine their own visual thinking and artistic skills.

Second, we learned that the multimedia features of Clover, recording your own voice and animating dialog, were *by far* the parts that users liked most. As one user exclaimed, "it was like making my own live comic!" Almost every user chose to record their voice as opposed to using speech synthesis. This could be due to the poor quality of synthesis, but given the overwhelming number of smiles and laughs that we observed, it is more likely due to users wanting to hear their own voices in the vignettes.

There were many requests for more multimedia features such as character motion, lip synchronization, and facial expressions. Tools such as Clover should strive to incorporate rich media as it is a powerful magnet for kids to *want* to learn about computing, and often results in learning artifacts, e.g., animated vignettes, that would not otherwise be possible or easy to create.

Finally, we observed that users were motivated to build vignettes. Motivation to tell stories has been shown in other domains [4, 12, 31], but it is encouraging to know that kids demonstrate similar motivation for building stories that express personal experiences. We observed that kids were genuinely focused on building their vignettes, not on learning the various nuances of our tool. For example, when questions were asked, they were almost always asked in context of the story, e.g., how to make a character speak, how to record a voice, or how to let others see the vignettes. This observation is simple, but powerful. Users' focus was on a meaningful learning goal – expressing personal experiences – not on the technology itself, a goal of many learning tools [23, 26].

## 7. DISCUSSION AND FUTURE WORK

We will first discuss how our existing implementation of Clover has met our design goals. To develop an interface appropriate for kids in grades 5-8, we developed an adult-oriented interface, but tried to make it more inviting through the use of larger buttons, more color and icons, rounded corners, less rigid fonts, minimal dialogs, and no top-level menus. Results from the evaluation confirm that kids found the tool easy to learn and *fun* to use, and that it was usable with both a mouse and stylus input device.

To employ constructivist theories of learning, our tool leads users through the process of constructing vignettes – writing a narrative and script, sketching characters and scenes, and animating scenes. Teachers were optimistic about kids being able to gain technology skills through the use of Clover. Once created, vignettes can be posted to a web site where other educators can access them.

For expressing personal experiences better than using just paper, our tool allows users to record their voices and animate dialog and thought among characters. Results from the evaluation show that teachers and kids produced animated vignettes that could not otherwise be created with just pencil and paper, and reported that the animated vignettes were more compelling / fun to create. Also, the multimedia features of our tool were the kids' favorite part. Future work should focus on extending these multimedia features.

Technology education and other skills are delivered through the process of constructing vignettes. For example, kids acquire keyboarding and verbal literacy skills when writing narratives and scripts, visual thinking and artistic skills when drawing characters and scenes, problem-solving skills when animating vignettes, and verbal and group communication skills when discussing vignettes.

Clover also exposes kids to a few basic computing concepts. For example, when adding a character to multiple scenes, class-instance relationships are being used. By placing actions in the Action Grid, kids are *programming* using a visual language. As kids arrange actions in the grid, they are manipulating (and thinking about) sequential and parallel behavior. Results from the evaluation show that both teachers and kids would like to use a tool such as Clover to learn more about computing. Of course, the full range of computing concepts recommended for kids [1] is far broader than the concepts available in Clover – and most other learning tools. Even if the range of concepts in Clover is not complete, the use of our tool still helps provide the scaffolding necessary for learning more advanced concepts in the future.

To facilitate delivery of character education, kids construct vignettes based on *personal experiences*. This engages kids in introspection and reflection about their moral and social thinking [11, 35, 36]. Authoring responses engages kids in perspective taking and problem solving the moral or social issue in the vignette. Classroom discussion seeded by the vignettes further taps critical thinking and allows appropriate social behaviors to be taught [8, 16]. Vignettes and responses can be placed on our Web site, enabling these learning artifacts to be reused. Results from our evaluation show that teachers recognize the benefit of using vignettes for character education and that our tool effectively supports vignette teaching practices. Using vignettes, however, should be just one part of a character education program [8].

To connect the delivery of technology and character education, kids use our tool for constructing vignettes based on their own personal experiences. We believe this creates an interaction effect. Kids become more engaged in using our tool because they are telling stories that are meaningful to them. The intense motivation with which kids were using our tool to build their vignettes offers compelling evidence to this effect. Also, since the vignettes are more expressive than those created with pencil and paper, the vignettes should have greater learning impact on their viewers.

Computational storytelling tools have used both 2-D (e.g., [6, 12, 31]) and 3-D (e.g., [5]) representations. We chose to use 2-D in our tool for at least two reasons. First, there is little empirical evidence showing that the increased visual realism possible with 3-D is more effective than 2-D for character education. Second, we wanted kids to draw their *own* characters and scenes such that the resulting vignettes would accurately (within limits of artistic skills) reflect their experience. With 3-D, users would likely be limited to manipulating characters and objects defined *a priori*, as free-form drawing in 3-D is extremely difficult, thus limiting the vignettes to what could be composed from existing objects.

Stories for character education are most effective when they are based on personal experiences [20, 36, 37]. Thus, our tool does not support collaborative input since expressing a personal experience is inherently an individual effort. However, consistent with [4, 34], we observed in our evaluation that users had a strong desire to share vignettes, turning their screens to show or walking over to other computers to view them. We believe that tools such

as Clover should explore methods to make vignette *activities* more collaborative. For example, a tool could allow kids to review other vignettes during construction. A tool could also allow part of a vignette such as a specific character or scene to be imported into another vignette. But this function would need to be balanced against wanting kids to draw most of their own content.

Beyond addressing known usability issues, our future work is to:

- *Compare different forms and fidelities of vignettes.* Vignettes come in many forms (text [9], video [10], and animated [37]) and fidelities (2-D [12] and 3-D [5]), but there is little data showing how these impact elements of character. We want to compare how vignettes rendered in text, video, 3-D, and 2-D (our tool) affect attitudes and responses related to character. Results would allow the utility of vignette form and fidelity to be weighed against the cost of developing/using related tools.
- *Conduct a field study measuring how use of our tool affects technology and character education relative to existing tools.* We want to deploy our tool and measure how using it to construct vignettes affects technology and character education relative to pencil and paper. For example, we would compare changes in attitudes about the use of technology, how the tools affected the process of constructing vignettes, and how using the resulting vignettes affects relevant attitudes and behaviors.

## 8. CONCLUSION

K-12 schools need to deliver effective character education and integrate the use of computers into meaningful learning activities. Building on the use of animated vignettes for character education, we have made several contributions addressing these problems.

First, we developed a novel computational tool that leads users through the entire process of constructing animated vignettes. We employed iterative design practices to overcome the challenge of building a tool that needed to support specific educational goals and practices while being easy to learn and fun to use for kids. Our tool can be downloaded and used, enabling and encouraging use of animated vignettes for character education on a large scale.

Second, by using our tool, kids are able to acquire and practice technology skills and gain experience with a few basic computing concepts. But this learning occurs within a learning activity that is meaningful to kids – expressing personal experiences. Thus, using our tool offers educators another opportunity for integrating the use of computers into meaningful learning activities.

Third, results from two evaluations confirmed that we have made significant progress toward our project goals. Users were able to build meaningful vignettes with our tool, teachers felt it would be useful for technology and character education, and kids felt it was easy to learn and fun to use. Others can draw upon our design rationale, results, and lessons when developing similar tools.

Finally, we showed how research in multimedia UI design was applied to a real-world problem. This resulted in a practical tool that enables use of multimedia for character education, enhancing kids' learning experiences. We hope this is just one of many tools that the multimedia community will produce for K-12 education.

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