# Spectrum Educational Tool: Animated Scenarios for Teacher Preparation

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Abstract

With the ubiquitous nature of information supported by the growth of the Internet, eLearning has become an effective learning mechanism, promoted as a method to reduce difficulties for learners. We developed the Spectrum educational tool as an online instrument to support preservice teachers in practicing classroom management techniques. This blended learning approach with the tool aims to incorporate animation-based case studies in the place of existing text-based case studies to help preservice teachers grasp concepts more effectively. Interactive case studies provide more support for content reinforcement, critical thinking, and reflection skills than text-based case studies. This work focuses on the behavioral problems teachers may face in the classroom, helping them overcome difficult situations by showing them effective ways of teaching and classroom management. The previous version of this project, developed using web development and Flash animation, is in the new web development standard for animation support HTML5 and JavaScript for the updated version. With this type of development, our application is supported on almost all devices and is cross-platform independent. The proposed design for the Spectrum educational tool was a low cost alternative and an interface that targets both web and mobile platforms. Preservice teachers may gain access to the application by registering, and our hope is that they find it interesting and helpful to access classroom management content and examples online. The goal of the Spectrum educational tool is to design and develop preservice teachers through interactive case studies.

***Keywords:*** *preservice teacher, teacher training, online learning, human computer interaction, eLearning platforms, classroom management, behavior management, animation*


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# Herramienta educativa Spectrum: escenarios animados para la preparación de profesores


## Resumen

Con la naturaleza ubicua de la información respaldada por el crecimiento de Internet, eLearning se ha convertido en un mecanismo de aprendizaje efectivo, promovido como un método para reducir las dificultades de los alumnos. Desarrollamos la herramienta educativa Spectrum como un instrumento en línea para apoyar a los maestros en servicio en la práctica de las técnicas de gestión del aula. Este enfoque de aprendizaje combinado con la herramienta tiene como objetivo incorporar estudios de casos basados en animación en lugar de estudios de casos existentes basados en texto para ayudar a los maestros en servicio a comprender los conceptos de manera más efectiva. Los estudios de casos interactivos brindan más apoyo para el refuerzo de contenido, el pensamiento crítico y las habilidades de reflexión que los estudios de casos basados en texto. Este trabajo se centra en los problemas de comportamiento que los maestros pueden enfrentar en el aula, ayudándoles a superar situaciones difíciles mostrándoles formas efectivas de enseñanza y gestión del aula. La versión anterior de este proyecto, desarrollada usando desarrollo web y animación Flash, está en el nuevo estándar de desarrollo web para soporte de animación HTML5 y JavaScript para la versión actualizada. Con este tipo de desarrollo, nuestra aplicación es compatible con casi todos los dispositivos y es independiente de la plataforma cruzada. El diseño propuesto para la herramienta educativa Spectrum era una alternativa de bajo costo y una interfaz que apunta a plataformas web y móviles. Los maestros en servicio pueden obtener acceso a la aplicación registrándose, y esperamos que les resulte interesante y útil acceder al contenido y ejemplos de gestión del aula en línea. El objetivo de la herramienta educativa Spectrum es diseñar y desarrollar maestros en servicio a través de estudios de casos interactivos.


***Palabras clave:*** *formación docente previa al servicio, aprendizaje en línea, interacción humano-computadora, plataformas de aprendizaje electrónico, gestión del aula, gestión del comportamiento*

# Spectrum教育工具：用于教师培训的动画场景


## 摘要

鉴于互联网发展为信息的普及性提供支持，电子学习已成为一项有效的学习机制，并作为一种为学习者减少学习困难的方法而受到推崇。我们提出一个在线工具—Spectrum教育工具，帮助职前教师练习课堂管理技术。这种用工具进行的混合学习方法旨在将基于动画的案例研究融入现有的基于文本的案例研究，以期帮助职前教师更有效地抓住概念。相较于基于文本的案例研究，这种将动画与文本结合的互动型案例研究为内容强化、批判性思维和反思技能提供了更多支持。这项工作聚焦于教师在课堂上可能面临的行为问题，并通过为教师展现教学和课堂管理的有效方法，帮助他们克服困难场景。为了准备更新版，这项计划的之前版本（通过使用网站开发和Flash动画完成）现在是提供动画支持的HTML5 和JavaScript的新网站开发标准之一。有了这种开发后，我们的应用程序几乎在所有设备上都能使用，并且具有跨平台独立性。为Spectrum教育工具提出的设计是一个低成本的替代措施，它还是一个以网站和手机平台为目标的界面。职前教师可能通过注册的方式获取该应用程序，同时我们希望教师能通过从在线获取课堂管理内容和案例中发现有趣性和有用性。Spectrum教育工具的目标是通过互动型案例研究，进而设计并开发职前教师。


关键词：职前教师培训，在线学习，人机互动，电子学习平台，课堂管理，行为管理

Many of the present applications available for instructing preservice teachers are not as engaging and effective as they should be. Various data show that applications developed using multimedia-based case studies improve the effectiveness of training. These applications make even the most challenging concepts easier to comprehend. The Spectrum educational tool, created to support teachers in practicing their classroom management techniques, derives its name from the light spectrum, as many colors may emanate from a prism based on the type of *input*. Like a beam of light *output* from a prism (e.g., a spectrum), in the same way, students need multiple types of learning opportunities (e.g., output) to support their various learning needs.

In order to support their individualized learning, we planned to create a spectrum of tools.

Specifically, we developed animation-based case studies to replace existing text-based case studies so that emerging teachers will grasp classroom management concepts more effectively (e.g., how to handle a classroom situation with a defiant student, how to attend to a student who makes inappropriate comments, etc.). The primary objectives of this project were to investigate preservice teachers' understanding of classroom management situations and application of learning to solve them. We developed an online educational application that supports preservice teachers, is easy to use, meets design requirements, and is engaging.

The use of animation-based case studies, which are more helpful for preservice teachers to understand classroom management skills, was the primary focus of this project. Teachers may access the information anywhere and at any time and be more engaged when content is delivered through user-friendly, interactive eLearning environments. Unlike traditional text-based case studies, this form of content aides preservice teachers with effectively understanding authentic situations that arise in classrooms. User interactivity plays a major role in online learning environments. Thus focusing on involving users in the learning process by providing them control over the flow is crucial.

## Literature Review

Significant interest in and development efforts to support communication and online learning are widespread. Computers are ubiquitous, and information is accessible at any time and in any place on a variety of devices. There is a greater focus on developing resources to support applications in a platform-independent way and provide greater access to information. With the prevalence of computer and mobile technology, eLearning is a method used to enhance the quality of teaching. ELearning integrates technologies and allows learners to gain knowledge with no time, location, or space constraints. The main goals of eLearning, according to Francis (2018), include:

- Enhancing the quality of learning and teaching;
- Meeting the learning style or needs of students;
- Improving the efficiency and effectiveness; and
- Improving user-accessibility and time flexibility to engage learners in the learning process.

ELearning helps with shifting the education paradigm from instructor-specific to learner-specific. Applications of eLearning are flexible and varied and include web-based learning, computer-based learning, and virtual education via the Internet, Intranet, CD-ROM, DVD, interactive TV, and other devices. With eLearning, many people around the world are study-

ing and completing their education (Cheng, Basu, & Goebel, 2009). In addition to students, eLearning plays an important role for professionals who need to stay abreast of the latest technologies or information. The successful implementation of eLearning applications ensures equal learning facilities in both rural and urban areas of any nation. Government and other private institutions are investing a significant amount of money in online education to spread education to all areas around the world; over $107 billion was spent on self-paced eLearning in 2015 (Nemo, 2015). The literacy rate should increase in many areas of world with the support of eLearning applications (Kazmer & Haythornwaite, 2004).

During the early stages of online programs, the primary concern of educators was whether the results were equivalent to traditional classroom learning. Studies confirm that there is no major difference between online and traditional classroom learning (Kazmer & Haythornwaite, 2004; Stack, 2015). Further, researchers predicted that adding a blended learning approach would be widely used in K-12 schools and universities (Porter, Graham, Spring, & Welch, 2014). Many multinational companies, such as BBC and Discovery Education, in collaboration with some institutions and universities, are offering online curriculum for diplomas and undergraduate and graduate programs. There is abundant material to explore in online education (Chen, Huang, & Shih, 2002; MindShift, 2014).

In many conventional web-based eLearning environments, students browse and consume static information. To make eLearning environments more effective, students need to interact with dynamic content. Many researchers are investigating user interaction aspects in eLearning settings. Studies show positive outcomes for students in interactive eLearning environments (Buchanan & Palmer, 2017; Fiorella & Mayer, 2016; Gao, Liu, & Paas, 2016; Jeno, Grytnes, & Vandvik, 2017). ELearning design increasingly focuses on how to make environments more interactive than before. Today, there are many eLearning web and mobile applications. The Spectrum educational tool is an online eLearning application that is accessed using web browsers, such as Firefox, Chrome, Opera, Safari, etc., and via mobile devices, such as an iPhone or iPad. It supports interactive simulations by enabling preservice teachers to interact with the multimedia component.

## *ELearning and Teacher-based Training*

With the advent of the Internet, preservice and inservice teachers may be trained using online learning environments without limitation of time, space, or location. One strategy for learning is *blended learning*, which integrates technology with traditional teacher-based training. Blended learning increases the effectiveness, efficiency, and satisfaction of learners (Kupetz & Ziegenmeyer, 2005; Porter et al., 2014).

Developers and designers should not assume that preservice teachers are aware of the latest technologies. Some online teacher professional development programs make it possible

for educators to communicate, share knowledge and resources, and reflect via asynchronous interactions. Many companies are developing more online learning applications for students and ignoring teachers' expertise. According to Berry (2009), 15% of teachers are involved in a professional online community and 28% have read or written a blog about teaching. A learning community of teachers, in an online environment, is designed to provide guidance to novice teachers through learning and sharing ideas online (MacKnight, 2008). We reviewed these and other online systems to reflect on their design before we redesigned the Spectrum educational tool to support teachers and preservice teachers in learning and refining their classroom management skills.

## Spectrum Development

Text-based case studies for preservice teachers are textual descriptions of an author who narrates the case study. For every case study, there are reflection questions based on the case study that allow teachers to think and analyze the scenarios. At the end of the case study, the narrator explains his or her analysis of the reflection questions and shares his or her thoughts. Dr. Tripp's idea and goal to provide more interactive content to support her classroom management courses prompted the creation of Spectrum. In our initial discussions (i.e., sessions about requirements), we identified compelling examples of situations where decisions in classroom management may improve the class or cause it to devolve into chaos.

### *ELearning and Case Studies*

With the advent of the Internet and applications to access information, learners have access to the content of their choice. Easy access to content has supported the concept of eLearning. Learning through the Internet offers many advantages, which include control over the content, learning sequence, and pace of learning. The main goal of eLearning is to provide content flexibly to learners without having to depend on time and location. According to data, 96% of Americans "now own a cell phone of some kind" (Pew Research Center, 2019, para. 2). Developing eLearning environments, which can also be accessible from mobiles, such as an iPhone, iPad, etc., is important because the growth of mobile technologies is substantial.

ELearning-based preservice teacher training reduces costs when compared to traditional classroom training. In traditional classroom training, case studies are mostly in textual form and are expensive company-based resources. In addition, text-based case studies do not create a quality impression of an authentic classroom for teachers. Transforming case studies from text-based to multimedia-based solves multiple problems.

Multimedia-based case studies allow teachers to grasp concepts more effectively, visualizing the classroom environment in a practical way. By incorporating the concept of multimedia in developing eLearning for preservice teacher training, participants may overcome various constraints of for-

mer methods of teacher training. Active learning helps students understand the content easily and remember it for a long time (Yengin, Karahoca, Karahoca, & Yücel, 2010). The style of the interaction utilized in developing case studies in the Spectrum educational tool supports novice teachers in classroom management and decision-making. This project sought to implement case studies for preservice teacher training to reduce time and place constraints, increase user interactivity, and create a visual impression of classroom experiences.

### *First Spectrum Version*

We proposed Flash-based animation for interactive case studies. At the time of initial design and development, Flash was the most popular method to animate webpages. The first version of the Spectrum educational tool involved developing animated simulations of case studies using Adobe Flash. Figure 1 shows a screenshot of this version.

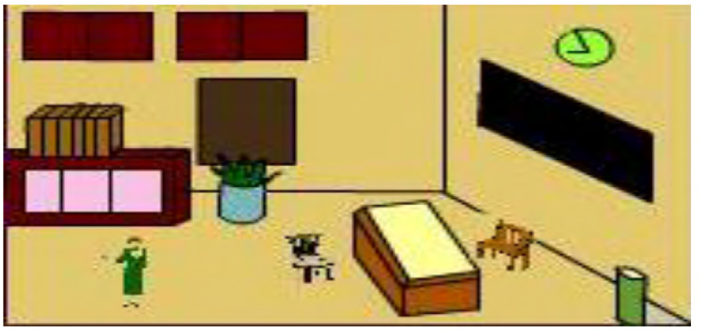

*Figure 1.* Screenshot of the first Spectrum application.

This initial version had various drawbacks. One was lack of user interactivity. Learners could not interact with the application. In addition, there was an issue with the aesthetic quality of the simulation: it did not look realistic because the character animations resembled a cartoon flipbook and were not continuous. The transition from scene to scene was not smooth.

Another drawback was the supportability of the application in all browsers. This application has no user interactivity associated with it. The user cannot control the flow of the application. The current version of the Spectrum application uses HTML5 and JavaScript, which most devices support. Table 1 shows the compatibility of HTML video and Flash video in different browsers or devices. This does not require the user to install additional software.

The Spectrum educational tool consists of a learning environment for preservice teachers. It is poised to replace current environments, which are not portable to multiple browsers and platforms. This application supports user interactivity. Its new version over-

**Table 1** *Compatibility of HTML Video and Flash Video in Different Browsers/Devices (Allen, 1998).*

| Browser/Device | HTML5 Video | Flash Video |
|---|---|---|
| Chrome | yes | yes |
| Firefox | yes | yes |
| Internet Explorer 6/7/8 | no | yes |
| Internet Explorer 9 | yes | yes |
| Safari | yes | yes |
| IOS | yes | no |
| Android | yes | yes |
| Opera | yes | yes |
| Others (feature phones) | no | no |

comes usability issues and converts text-based scenarios to multimedia scenarios. The text-based case studies make the visualization of class environments more challenging and clearly lack features, such as user interactivity and good usability.

In this environment, the user may control the flow of the application. Users interact with the application and share their opinions on the case study. This structure provides reflection questions for each case study, which allows preservice teachers to work through their ideas in a thoughtful manner. This gives them an opportunity to prepare for various classroom scenarios they may encounter when teaching.

### *The Spectrum Educational Tool Software Modeling and Software Life Cycle*

This project employed evolutionary prototyping (EP), which is a process that differs from throwaway prototyping/programming, where you build a prototype and possibly abandon it. Using EP, the design team plans to iteratively refine and improve the application until it meets a satisfactory level of performance as requested by the client (Crinnon 1991; Davis 1992). Our main goal was to build a robust and flexible prototype in a structured manner and constantly refine it based upon feedback. (See Figure 2.) This process allows a continuous refinement of the system and developers to tweak parts of the application that they better understand without needing to worry about those they understand less. The Spectrum educational tool is an application developed based on the improvements in the existing application and new requirements from the user. We made the new application more interactive and helpful to teachers by providing them control over the content.

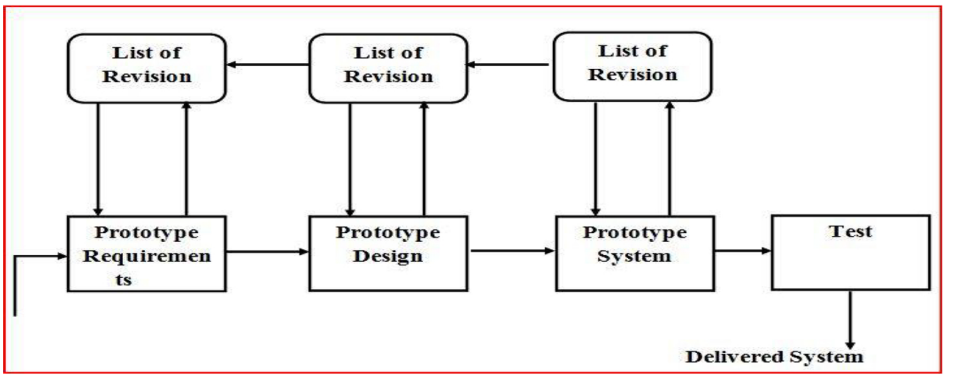


*Figure 2.* Prototyping model used in the Spectrum educational tool

In EP, functionalities are integrated on an interim basis until the final system is delivered. As discussed, we developed this application in HTML5 and JavaScript to work on mobile devices. We sent every case study to users for functionality testing.

We used a questionnaire in SurveyMonkey for the usability testing for this prototype version, where the teacher education specialists, Human Computer Interaction (HCI) specialist, and various students responded to questions. Based on an analysis of the results, we completed further improvements.

## *The Spectrum Educational Prototype Use-Case Scenarios*

A use-case diagram in Unified Modeling Language (UML) is a behavioral diagram defined by and created from use-case analysis. It represents a graphical overview of functionalities provided by the system in terms of actors, their goals, and any dependencies between those use-cases.

**Use case for user**

*Primary Actor:* User

*Secondary Actor*: None

*Description:* This use case is for users who need to register for the first time to log into the application to access the case studies. The request sent by the user goes to the Database (DB) Administrator. The DB Administrator accepts the request and approves the login credentials.

*Pre-Conditions:* The user has a desktop/laptop/mobile device in working condition with Internet connectivity and installed browsers, such as Firefox, Chrome, or Safari, to open the application.

*Post Conditions:* The DB Administrator acknowledges and approves login credentials for the requested users.

*Basic Flow:*

- The user sends a registration request to the DB Administrator with his or her email, username, and password.
- The DB Admin can accept/reject

the request based on the availability of username.

- If the DB Admin accepts the request, the user is given access to the application.
- If the DB Admin rejects the request, the user must select a new username.
- Once the user has the login credentials, he or she can access case studies related to the Spectrum application.

Figure 3 illustrates the Basic Flow use-case.

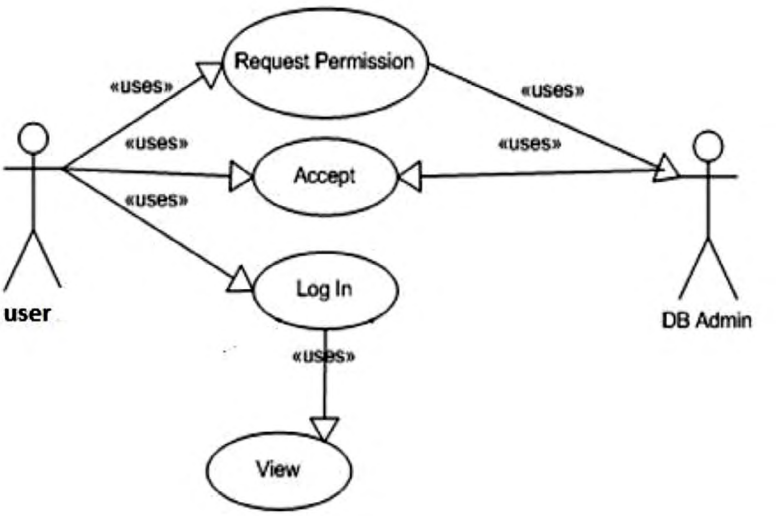


*Figure 3.* Use-case for user.

### Testing the environment

Data collection included three sets of participants: Auburn University undergraduate and graduate students in the Department of Computer Science and Software Engineering who are doing their research in the HCI lab, HCI specialists, and teacher education specialists who teach different case studies to preservice teachers. Data collection took place via https://www.surveymonkey.com/, with data stored electronically within the SurveyMonkey website.

## User Feedback

We purport that online learning environments with multimedia case studies are more effective than text-based case studies in providing understanding of various difficulties faced in classroom teaching. Teachers may access information without depending on time and location in online learning environments. Content is more engaging when delivered through easy, user-friendly, interactive applications in online settings.

We developed a questionnaire comprised of a set of questions, each having ratings for users to specify their level of agreement with how comfortable they feel with the application. We sought feedback about the prototype through questions related to *information quality* and *interaction quality*.

## Implementation

We developed the Spectrum educational tool using the following scripting programing languages: HTML5, PHP, CSS3, JavaScript, and MySQL. We used Microsoft Expression Web 4 as a web development application tool. The Spectrum educational tool authenticates students, or preservice teachers, with the help of a username and password. Students register by giving their username, email address, and password to gain access to the application. The login and registration pages were developed using PHP and MySQL as a database to store students' information. We developed the animated case studies using HTML5, CSS3, and JavaScript. The following sections include details about these technologies.

### *Development*

All of the features included in the existing versions of the Spectrum application were analyzed previously. New requirements were gathered in a participatory *requirements and design* exercise by Dr. Tripp; gathered requirements were then analyzed based on EP. EP allows a continuous refinement of the system and is based on the understanding of the requirements by the developers. A paper prototype was proposed based on these requirements. Paper prototyping is a widely used method in the user-centered design process. It helps developers build software that meets the expectations and needs of users. It is also used for usability testing of websites, web applications, and conventional software. It saves time and money since developers can test the interfaces of software before they begin development. Figure 4 shows an example scenario in initial paper prototype form.

Initially, we developed scenarios along with the descriptions in Microsoft Word as paper prototypes. The paper prototypes of case study scenarios were developed to illustrate decision points where making good classroom management decisions will be beneficial. We designed the terms in the scenario to be understandable to preservice teachers. The interface provides information so that the teachers may make some decisions at the end of the case studies. Each case study ends with a set of reflection questions prompting them to solve classroom management problems through their understanding of the scenarios. In the design, we consider the page layout and its size and platforms based on the final deployment to support presentation of the animated case. The following figure is a paper prototype that illustrates our vision of a classroom scene.

The research group from the HCI laboratory, in collaboration with Drs. Tripp and Seals, initially evaluated the paper prototypes. The paper prototypes were refined based on the feedback. Af-


*Figure 4.* Paper prototype.

ter finalizing the paper prototypes, we converted them into animations. We built webpages to embed the animated case studies. Using case studies from the textbooks *Learning from Cases: Unraveling the Complexities of Elementary Science Teaching* (Tippins, Koballa, & Payne, 2001) and *Teaching in Today's Classrooms: Cases from Middle and Secondary School* (Redman, 1998), we developed animated case studies in the application. We focused on general classroom management scenarios and solutions, such as how to deal with apathetic or defiant students.

Figures 5 and 6 illustrate the example from the *Learning from Cases* book's Chapter 3 and *Organizing Meaningful Science Learning Environments* webpages. It includes side links for different case studies in Chapter 3. The user can click on *Up to Chapter 3* link to go back and view all of the chapters.

Figure 7 shows the webpage for *Case Study 3.2: To Group or Not To Group*. The page consists of a description of the case study, video to view the animated scenario, and link for reflection and discussion questions. The user may click on the *Up to Chapter 3* link to go back and view all of the chapters. We developed all of the webpages using HTML5 and JavaScript.

For the development of animated simulations, all of the images required to develop the scenario were collected and edited using Microsoft Paint and GIMP. We used Microsoft Paint and GIMP to convert various images in different ways so that we could represent characters in the case study in different forms (see Table 2).

The reflection questions (see Figure 8) then enabled the preservice teachers to think about and understand different challenges they may face with-

in their own classrooms. We provided viewable explanations for the correct answers at the end of the reflection questions.

The application was interactive and allowed preservice teachers to participate in the flow of the learning process. The animated simulations developed are more useful and make a deeper impact on participants than other forms of teacher training methods. The animated simulations allow preservice teachers to view the classroom environment and prepare for different types of problematic situations that they could encounter.


*Figure 5.* Learning from Cases page.


*Figure 6.* Organizing Meaningful Science Learning Environments page


*Figure 7.* Case study 3.2: To Group or Not To Group page.

**Table 2** *Video Formats Supported by Different Browsers/Devices (Allen, 1998).*

| **Browser/Device** | **Video Formats** |
|---|---|
| Chrome | MP4, WebM |
| Firefox | WebM |
| Internet Explorer 6/7/8 | MP4 |
| Safari | MP4 |
| IOS | MP4 |
| Android | MP4 |
| Opera | WebM |


*Figure 8.* Webpage for reflection and discussion.

## Results and Analysis

One of the objectives of this project was to investigate methods that facilitate preservice teachers' understanding of traditional classroom experiences. Another focus was to investigate the affordances and constraints involved in developing an interactive online application that was easy to use, meets all of the requirements, and was engaging for learners. We successfully developed this application to be accessible across different web and mobile platforms.

Participants responded that the system was comfortable to use and that they had no problems with navigating it. We found existing preservice teacher training tools to be very static, with very little user interaction. The Spectrum educational tool provides a system that is easy to navigate, provides case studies to support reinforcement of classroom management strategies, and includes great animations with interactive content.

### *Results of Usability Testing*

Again, we tested the Spectrum application tool with three groups, including university students, teacher education specialists, and HCI experts, using a SurveyMonkey questionnaire. The results from the surveys provided information about the developed application and whether it was acceptable for preservice teacher training. Thirty-nine users participated and gave their opinions in the usability testing survey.

The usability testing consisted of three sections. The first section was a pre-survey to collect demographic data. The second section had non-trivial tasks to be performed by the participants. The third section was a post-survey consisting of questions regarding information quality and interaction quality. A Likert-type scale was used for the questionnaire and the results of the pre-survey are provided in Table 3.

Table 3 provides a summary of the pre-survey results reported by the participants. Of the participants, 68%

**Table 3** *Pre-Survey Results.*

| Question | Response |
|---|---|
| Do you have prior experience working in an online learning environment (i.e., Blackboard, Moodle etc.)? | Yes – 68.2%<br>No – 31.8 % |
| Do you feel you and your peers can learn better through online learning environments than traditional classrooms? | Yes – 68.2%<br>No – 31.8 % |
| Do you feel that online materials can enhance traditional classroom materials? | Yes – 91.1%<br>No – 8.9 % |
| Do you believe teacher training should involve more online teaching tools as a method to supplement traditional classroom learning? | Yes – 83.3%<br>No – 26.7 % |

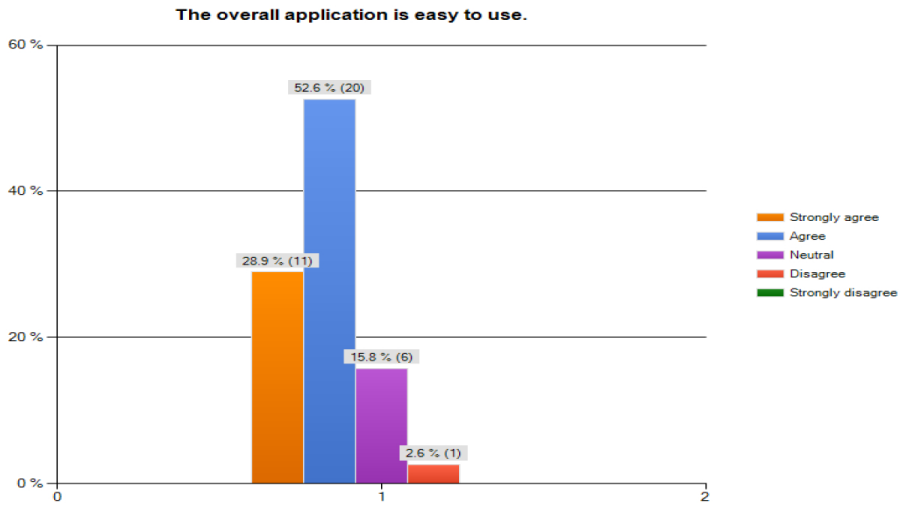


*Figure 9.* Bar chart showing the participants' response to *How easy it is to use the system?*

have prior experience working in an online learning environment and feel that they may learn better through online learning environments than traditional classrooms, 91% reported that online materials might enhance traditional classroom materials, and 83% believe that teacher training should involve more online teaching tools as a method to supplement traditional classroom learning.

The results of the post-survey presented the participants' perceptions of the Spectrum application tool from the usability point of view. Average responses to all of the usability questions indicated a positive response to the application. Data were collected on a five-point scale, with *strongly disagree* being the lowest and *strongly agree* being the highest. On a scale of 1-5, the average rating for each question in the survey was nearly 4. The response to the system was better than expected.

Figure 9 shows the participants' responses to the usability question *The overall application is easy to use* regarding the Spectrum educational tool. Of the participants, 52% *Agree* that the application was easy to use and 30% *Strongly agree* that the application was easy to use. However, 18% of the participants indicated that they did not find it easy to use the application. This indicates that we need to provide greater support and improved usability for novice users with less computing efficacy.

Table 4 provides a summary of the post-survey questionnaire reported by the three sets of participants regarding the usability of the application. Judging by how users rated the system, we conclude that most of them responded that the developed system had better usability features. This supports one of the goals of the project, which was to build a learning environment that was intuitive, user-friendly, and easy to use and learn.

The results in Table 4 indicate *Strongly agree* or *Agree* responses for all of the questions regarding the information and interaction quality of the application. The results indicate that videos for the case studies were helpful for teachers in preparing for varied classroom environments and scenarios. This shows that the developed system was useful for the preservice teachers to think about different problems that they might face when teaching. The responses also revealed that participants felt the reflection questions after the case study were helpful.

Another goal of the project was to allow teachers to visualize the traditional classroom environment. Of the participants, 79% reported they could visualize the classroom environment through animated simulations, 89% believed that the information would be helpful for preservice teachers to prepare for classes, and 89% believed that the application would provide reinforcement of material already taught in their classroom management course.

We tested the Spectrum application tool against the following range of usability factors: dull – stimulating, rigid – flexible, terrible – wonderful, frustrating – satisfying, and difficult – easy. The results indicated that most participants found the application flexible, wonderful, easy, stimulating, and satisfying. The Spectrum application received the following rating with bi-polar rating scales: 3.74 rating average in dull – stimulating, 3.85 in terrible – wonderful, 4.18 in difficult-easy, and 4.35 in frustrating – satisfying.

### *Participant Comments*

Some participants made specific comments in regards to the application in the post-survey questionnaire and many comments were positive. The participants indicated that the application's flexibility was improved, easy to understand, and easy to navigate and that the design was good. The participants positively commented on the reflective questions provided at the end of the videos and were appreciative that the application is supported on mobile devices. The negative comments made by participants were that the website is very small on phones and that they did not care for the robotic voice.

## Conclusion

The Spectrum educational tool is an application that aids teachers and preservice teachers by virtually presenting classroom management scenarios in an interactive and engaging manner. It exposed student teachers to more classroom management scenarios, techniques, and environments using this application. The Spectrum educational tool allows teachers to visualize classroom environments through animated simulations in a practical way. Conveniently, it can be accessed from both web and mobile platforms easily. Usability testing showed that the application is easy to use and supports teachers in their teacher training processes. The animated simulations support novice teachers in classroom management development and decision-making. Based on the results of our project we

**Table 4** *Post-Survey Results.*

| Question | Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Rating Average |
|---|---|---|---|---|---|---|
| The home page is attractive. | 33.3* | 51.3 | 12.8 | 2.6 | 0 | 1.85 |
| The typography (lettering, headings etc.) is attractive. | 28.2 | 51.3 | 17.9 | 2.6 | 0 | 1.95 |
| It is easy to find my way around the site. | 42.1 | 55.3 | 2.6 | 0 | 0 | 1.61 |
| It is easy to remember where to find things. | 38.5 | 56.4 | 5.1 | 0 | 0 | 1.67 |
| It is straightforward to perform tasks. | 43.6 | 41 | 15.4 | 0 | 0 | 1.72 |
| The video of the scenario within the Spectrum application is better reading the scenario from a textbook. | 25.6 | 48.7 | 20.5 | 5.1 | 0 | 2.05 |
| It is easy to navigate back and forth through different case studies. | 28.2 | 64.1 | 7.7 | 0 | 0 | 1.79 |
| The overall application is easy to use. | 28.9 | 52.6 | 15.8 | 2.6 | 0 | 1.92 |
| The application is appropriate for a mobile device. | 18.9 | 48.6 | 21.6 | 8.1 | 2.7 | 2.27 |
| People with limited computer experience can use the Spectrum application. | 28.9 | 68.4 | 2.6 | 0 | 0 | 1.74 |
| The information provided in the system is easy to understand | 28.9 | 60.5 | 10.5 | 0 | 0 | 1.82 |
| The organization of information in the scenarios is clear. | 34.2 | 55.3 | 10.5 | 0 | 0 | 1.76 |
| The videos developed for presenting scenarios are interesting. | 21.1 | 63.2 | 13.2 | 2.6 | 0 | 1.97 |

| | | | | | | |
|---|---|---|---|---|---|---|
| I could practically visualize the classroom environment through animated simulations. | 18.4 | 60.5 | 18.4 | 2.6 | 0 | 2.05 |
| The information will be helpful for pre-service teachers to prepare for classes. | 25 | 63.9 | 8.3 | 2.8 | 0 | 1.89 |
| Reflection questions allowed me to think about different problems that can be faced while teaching classes | 23.7 | 65.8 | 10.5 | 0 | 0 | 1.87 |
| Feedback to the reflection questions was helpful. | 23.7 | 60.5 | 13.2 | 2.6 | 0 | 1.95 |
| The application will provide reinforcement of material already taught in the classroom. | 18.4 | 71.1 | 10.5 | 0 | 0 | 1.92 |
| Based on this experience, I would use an application like Spectrum to review materials to support classes. | 23.7 | 60.5 | 13.2 | 2.6 | 0 | 1.95 |
| Overall, I am satisfied with the system. | 34.2 | 57.9 | 5.3 | 2.6 | 0 | 1.76 |

*All values are percentages

conclude that this application provides reinforcement activities for preservice teachers to gain strategies to teach with a better understanding of classroom management techniques and potentially reduce classroom challenges.

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