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〈Research Report〉

# Evaluating Educational Software and How It Assists Early Child Development and Learning

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Abstract

As technology progresses, it is more important than ever to analyze how technology can be used to enhance education and learning, and especially education and learning for young learners. This paper evaluates two pieces of software, *Kinect Sesame Street TV* for the Xbox 360, and the Dinosaur Encyclopedia Laptop Computer by Sega in order to determine the educational benefits of each. It determines the appropriateness of each in regards to a number of factors, including intended age group, ease of use, and relevance of programs. It analyzes both pieces of software using criteria from Plowman et. al's 2012 essay to evaluate how effectively a child is able to acquire operational skills, extend their knowledge of the world, and develop dispositions to learn using the software. In doing so, the paper highlights the benefits and limitations of the options available to assist in young children's educational development. This paper adds to our understanding of the effectiveness of educational software. Further research must be done for new software that is released, as well as new technological hardware, from both the perspective of the educator and the student to fully evaluate software and its educational effectiveness in the future.

Key words: Early child development, Educational software, Digital technology, Early years learning

"It was also a lot easier for online teachers to hold their students' attentions, because here in the OASIS, the classrooms were like holodecks.[1] Teachers could take their students on a virtual field trip every day, without ever leaving the school grounds."(Cline, 2011)

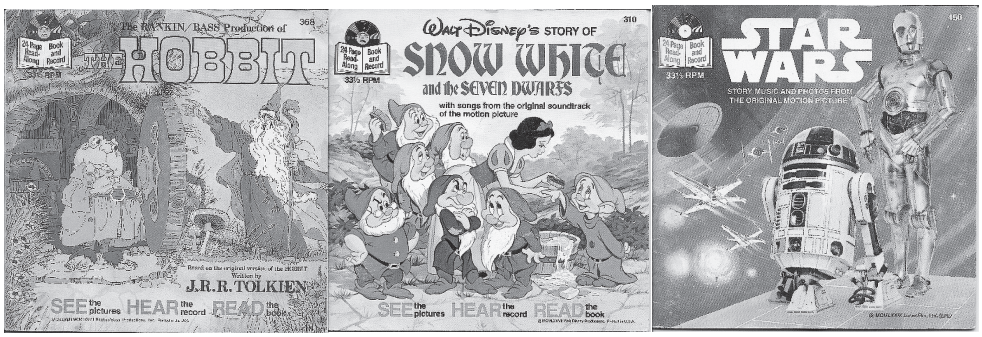
Yes, this excerpt from *Ready Player One* by Ernest Cline (2011) is a work of science fiction, but at the rate virtual reality and haptic feedback technology has been progressing, it will not be long before virtual classrooms are a reality. A reality that seems even closer as online lessons and hybrid lessons have become more prevalent recently due to the COVID-19 pandemic.

Technology and its evolution is evident throughout the course of education. Stories were handed down by oral tradition until the inventions of hieroglyphics, Romanized characters, and Chinese characters. Papyrus was used as the first paper, and Gutenberg's printing press in 1440 was

revolutionary because texts no longer had to be copied by hand.

Audio books for both children and adults have progressed from record to cassette tape, to CD, and can now be found in their entirety on YouTube.

Selected assortment of audio books with records, circa 1983:




Computers of the 1950s were gigantic calculators; now almost everyone around the world carries one in their pocket in the form of a smartphone. Answers to almost any question are accessible at any time via the internet.

Technology continues to advance at such a fast rate that as soon as a computer is sold it is already outdated.

As technology has advanced, its applications for education have advanced with it (Adcock, 2008). Now in the digital age, there is a plethora of hardware and software that can enhance children's development in both the home and an educational setting. Digital devices such as laptops, tablets, and smart phones have become an integral part of many children's educational development. With further advances in technology, and the easy availability of most of this technology to the general public in many countries across the world, it is important to consider how this technology is used, and what its effects on learning are. An important question arising from this is, is education as a field evolving quickly enough to make proper use of advancements in technology? If, as studies show, the average six-year-old child in the UK understands more about digital technology than a 45-year-old adult (Ofcom, 2014), would it not be better as educators to try to incorporate as much technology as possible into curriculum to support students with modern strengths and develop their ability to utilize computer science and telecommunications?

Having briefly reviewed the history of educational technology, in the remainder of this paper we will draw on some of the important research covering educational technology's use in early child development currently being studied and implemented in classroom settings, and use it to analyze and evaluate two proprietary software programs and the hardware required to run them: The Microsoft Kinect camera and *Kinect Sesame Street TV* for the Microsoft Xbox 360, and the Dinosaur Encyclopedia

Laptop Computer by Sega. It will determine the appropriateness of each in regards to a number of factors, including intended age group, ease of use, and relevance of programs. In doing so, we will highlight the benefits and limitations of the options available to assist in young children's educational development.

## LITERATURE REVIEW

### Educational Technology in Educational Settings

Over the last forty years there has been a shift in the discussion surrounding the use of digital technologies in education from an approach based on whether they are 'good' for children to a focus on how they can best be used in order to enhance children's learning (Palaiologou, 2016). As Roumell and Salajan (2016) argue, by the turn of the 21st century, educational technology had emerged as an important aspect of education, not just in developed countries, but across the entire globe. Technology use in schools is now almost universal throughout developed countries, and is widespread in nurseries and other early year's centers. In 2009, 97% of American classrooms had at least one computer, while 93% had internet access. In 2019, those figures had increased to 99% of schools having access to digital learning and high-speed broadband internet (EducationSuperHighway, 2019). Information and Communication Technology (ICT) classes have become an integral part of the curriculum in countries such as The United States and The United Kingdom, and hardware such as interactive whiteboards have gradually replaced outdated whiteboards and blackboards, with 97% of UK primary schools and 91% of UK secondary schools utilizing them by 2020 (CooperGibson Research, 2021). Since the emergence of the COVID-19 pandemic in 2020, there has been an increased focus on the use of technology in learning, with many schools resorting to e-learning, both synchronous; using Web conferencing software such as Zoom and WebEx, for direct student – teacher interaction and classes, and asynchronous; using YouTube and other multimedia platforms to deliver lessons and other important information (OECD, 2021).

### Educational Technology in the Home

It is not only in educational settings that technology fulfils an important role in assisting learning; computers and other digital devices have become commonplace in most households. As mentioned in the previous paragraph, the current educational shift towards e-learning makes computers, tablets, and mobile devices an integral part of children's education. However, most of the technology young children will encounter at home will be in the form of toys, games, and other forms of entertainment. This does not mean that children are not learning through these interactions. As Paley (2004) points out, there is

a strong connection in Western society between learning and play during pre-school years. It is through this play that children begin to form concepts about how everyday objects, and even the world around them, work. Although there are many studies into the use of technology by older children in the home, there is a lack of research on the use of technology by pre-school children (McPake et al., 2013). The few studies that are available give some valuable insights into how this technology can be utilized to assist in young children's learning. The majority of this research has been carried out by one of the most prolific academics in this field, Lydia Plowman. Much of her data was gathered through case studies of three- and four-year old children in the United Kingdom and their families. Her studies cover a variety of research into this area, such as how to enhance young children's learning through technology, the creative use of apps by young children, and how digital technologies are used in play and learning.

## The Evaluation of Using Technology to Aid Early Learning

What do young children gain from using technology in their learning process? American research has found that more children aged between two and five with internet access at home knew how to play a computer game than swim or ride a bike (AVG Technologies, 2010). Plowman et al.'s (2012) framework developed through detailed analysis of video recordings of young children in preschool settings suggested four main areas of learning:

- Acquiring operational skills; finding out how technology works and how to use it.
- Extending knowledge and understanding of the world; finding out about people and places through a variety of subjects.
- Developing dispositions to learn; gaining self-confidence through getting better at using technology.
- Understanding the role of technology in everyday life; learning how technology can be used to achieve a variety of tasks through observing adults' usage.

Taking a more specific lens, Mclean's (2017) research demonstrates how technology in the early years can enhance pedagogic practice in literacy, while Aldossary et al.'s (2021) study, which focused on young children's iPad use, found iPads enhanced four- and five-year olds' language learning, including their vocabulary development.

## Some of the Issues Involved in Using Technology to Aid Early Learning

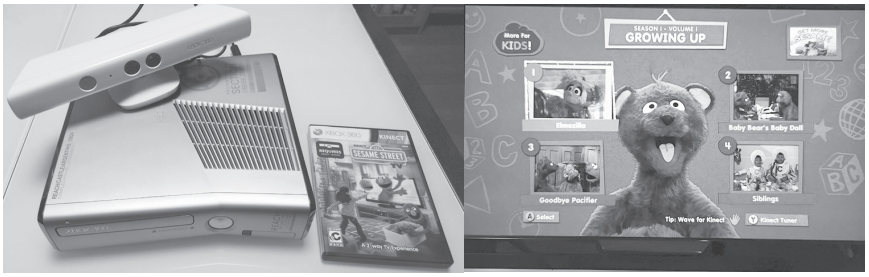
The debate over the dangers of children using technology is a varied and complex one. Topics range from the negative effects on children's physical wellbeing, such as eyesight and posture, to the mental aspects of too much computer use leading to social isolation, depression and other related conditions

(Plowman et al., 2010). There is also the issue of how much screen time young children should be allowed to have. In 1999, the American Academy of Pediatrics' Committee on Public Education recommended parents to not allow children under two to watch television. With the advent of laptop computers, tablets and mobile phones, these devices were also placed on the prohibited list. This advice has varied with time and also by country, with a more recent report by the US Government Office of Educational Technology advising that children under two should only watch media in the presence of an adult (Lauricella et al., 2015). Another widely discussed topic about technology use by children is the digital divide. The current COVID-19 pandemic has provided even more evidence of the impact of socio-economic factors when it comes to the effectiveness of e-learning, with both intra- and inter-country studies showing that children living in poverty with less access to technology have had their education much more seriously impacted than those from more financially stable families (Cullinane & Montacute, 2020; OECD, 2020).

## SOFTWARE REVIEWS

Over the years there has been a number of papers on evaluating the educational benefit of technology. Examples of these include Wrench`s (2001) Educational Software Evaluation Form, and Plowman et al.`s (2012) learning criteria. Jason Wrench provides a detailed checklist of criteria for educational software to be evaluated. Certain information deemed viable for a complete rating has been omitted for the purposes of this article, such as technical specifications including memory, CPU, hard disk space, and the publisher's address.[2] As outlined in the literature review, Plowman et al.`s (2012) research looks at three factors: Acquiring Operational Skills, that is, whether children need or acquire the skills to operate the software and hardware during use; Extending Knowledge of the World—does it expand the child's knowledge of information and cultures; and finally Developing Dispositions to Learn—does the software motivate and create the desire for the student to learn more? Elements of both these evaluation methods will be used to evaluate the following two pieces of technology.

## SOFTWARE REVIEW: KINECT SESAME STREET TV




Title: Kinect Sesame Street TV

Grade Level (Age): ESRB Rating EC (Early Childhood, suitable for ages 3 and up)

Operating System: Microsoft Xbox 360

Publisher: Microsoft Studios

Content:

*Sesame Street* has been renowned for children's educational entertainment since 1969. The show is well known for its diverse community of multicultural actors and situations and is appropriate for viewing in a wide range of countries and cultures.

*Kinect Sesame Street TV* uses the Xbox 360 video game console and the Kinect sensor peripheral to provide an interactive experience during eight episodes of the *Sesame Street* television show. The Kinect sensor can track body movements, and the camera places the child or children on screen so they can feel as if they are part of the episode. It is a kind of reverse augmented reality (AR) in which video objects are not added to real situations and environments, but the child is instead added to the simulated *Sesame Street* environment and situations.

Children can use the motion sensing technology to move their hand to select episodes to play. In the episode, children move their body to jump, throw basketballs to Elmo on screen, water plants, or locate hidden icons during the story segments. Performing certain actions or meeting requirements will unlock achievements.

The first disc, “Growing Up,” discusses themes such as growing up, sharing and family, which children can very much relate to. The second disc, “Science,” covers basic science themes and relevant skills such as measuring distance or how to protect fragile objects such as eggs. As per every standard episode, a letter and number are prioritized throughout the episode and reinforced through use of vocabulary or situations that require spelling or counting with the target language.

Usabilty / Adult Involvement:

As mentioned previously, the children’s bodies become the controller for the game as the Kinect sensor does an excellent job of motion tracking for this piece of software. Pointing or waving will give access to all of the menus the children will need to effectively play each episode. The children also appear on screen at certain times throughout the episode, allowing them to feel like they are included in the *Sesame Street* world. This allows for the parent or teacher to minimally supervise the children while they are utilizing the software.

Setup and navigating the Xbox 360 home menu, on the other hand, requires much more adult involvement than the game itself. The Xbox 360 system must be connected to a television set, the Kinect sensor must be connected to the system, and a controller must be used to navigate the menu. The controller must also be used to call up information on the in-game achievements or exit the software.

## Evaluation using Plowman et al.'s Criteria

Using three of Plowman et al.'s (2012) criteria, the types of learning involved in the operation of this program are as follows:

### Acquiring Operational Skills:

Because *Kinect Sesame Street TV* is by definition a Total Physical Response experience (Asher, 1969), it provides multiple benefits to learners with multiple learning styles (Gardner, 1983). In a regular episode of *Sesame Street* there are numbers and activities shown for logical-mathematical learners, dialogue for linguistic-verbal learners, and songs for musical-rhythmic learners. The software adds the styles of visual-spatial as actions the child performs interact with the world on screen. The use of the Kinect sensor and motion controls naturally benefit bodily-kinesthetic learners.

The many actions performed during the experience are the same as they are with real-world objects, so the game directly translates actions from a virtual world to real life, and vice versa. Hand-eye coordination is tested and improved as the user sees their actions and their results on screen and has to adjust accordingly. Parts of the story feature a hide-and-seek game where the child can locate hidden objects, unlocking an achievement if all are found. This also adds to the replay value, as she or he can try again depending on how many they missed. Lateral movement and spatial awareness are also improved as the user moves around the room in front of the camera while using the software. The navigation of menus in game may not translate to technology at present, but children who experience this game will be well prepared to use technology such as that seen in Minority Report[3] if that becomes reality.

### Extending Knowledge of the World:

This criteria is met in each of the episodes through a unique story that relates to aspects of the real world, such as observing an aquarium, resolving fights with family members, and letting go of a pacifier or security blanket of sorts. However, due to the nature of the DVD format, Season One is limited to eight interactive episodes over two discs. A second season was implemented as a downloadable program, but further downloadable content (DLC) was not implemented. This affects both the breadth of content available as well as being unable to advance as the learner progresses.

### Developing Dispositions to Learn:

*Kinect Sesame Street TV* develops dispositions to learn through friendly and familiar characters and by offering real-life situations with which children can relate. The age level and current language ability would naturally determine how well the learner is able to understand the story or concepts told in the episode.

The duration of each episode is no longer than a regular episode of *Sesame Street* and children should have little difficulty maintaining their attention span or avoiding fatigue from interacting during the episode.

One of the weaknesses, however, is that student motivation may decline after repeated playthroughs. Adkins (2021) uses a modified version of Blanchard's Situational Leadership II model (1985) to identify student motivation at various stages of educational development. While children may initially be interested in the game due to familiarity with the characters or interest in the Kinect technology, the inability to progress in level or participate in additional episodes limits their ability to learn using the program. This would require additional support and programs to move to higher levels of learning.

Summary:

*Kinect Sesame Street TV* receives high marks for student involvement. Being able to see themselves on screen in the *Sesame Street* world excites the players and the movement tracking is excellent for this piece of software. *Sesame Street* and its multicultural, multiracial topics and cast provide excellent opportunities to experience these topics at an early age while practicing letters, vocabulary, numbers and learning morals from the stories presented in each episode. Another main strength of *Kinect Sesame Street TV* is that it tests motor skills, and hand-eye and body coordination are required or developed to achieve the objectives throughout the episode.

A main weakness of the software is that the student cannot take control over the rate of presentation. Parts of each episode function like a normal television program and proceed at a set pace. Because each episode is self-contained, there is no possibility for expansion of topics within the software itself and would rely heavily on parent or teacher supplementation. *Kinect Sesame Street TV* would have to be implemented into a very basic existing curriculum. It could be used in pre-school or kindergarten settings, but older classes might see diminishing returns in educational benefits.

## SOFTWARE REVIEW: DINOSAUR ENCYCLOPEDIA LAPTOP COMPUTER


The Dinosaur Encyclopedia Laptop Computer is an integrated system incorporating both hardware and software. It Is marketed at Japanese speaking users between the ages of three and eight. It is modeled on a simplified version of a standard laptop, with a screen, keyboard and mouse, with which the user can interact with the software.

Title: Dinosaur Encyclopedia Laptop Computer

Grade Level (Age): Suitable for ages 3 to 8 years old

Operating System: Integrated into hardware

Publisher: Sega

Content:

There are a total of 136 individual programs encompassing a wide number of curriculum subjects, all of which are related to the central dinosaur theme. The curriculum areas covered are Japanese, Math, English, Life, Computer Skills, Games, Music, and Art. There are even three programs which enable the user to practice some rudimentary programming skills. Alongside these subjects there is a battle mode, which enables the user to control their own dinosaur and fight against other dinosaurs. This battle mode is linked to an inbuilt dinosaur encyclopedia, which starts off with just a few entries, although fact sheets for 152 dinosaurs can be unlocked through victories in the battle mode. There is also a dinosaur stamp rally that rewards the user for successfully completing the educational programs.

Usabilty / Adult Involvement:

The computer is fairly straightforward to use for a child within the appropriate age range. Due to its similarity to an actual laptop, it provides the user with a good approximation of how a laptop is used. The main point of interface is the mouse, which can be customized by the user to represent one of six different dinosaurs. The keyboard is more complex, with a standard Japanese keyboard layout, and requires the user to have a basic knowledge of the hiragana system. Many of the programs can be used by children on the lower end of the age range, although for some of the programs, especially the language-based ones, basic literacy skills are needed and so are more suitable for older users. In terms of parental / adult guidance, younger children will need assistance in playing some of the aforementioned literacy-focused programs. However, a majority of the users will need some degree of assistance when using the encyclopedia, as some of the terms and vocabulary used are fairly advanced.

## Evaluation using Plowman et al.'s Criteria

Using three of Plowman et al's (2012) criteria, the types of learning involved in the operation of this toy are as follows:

Acquiring Operational Skills:

The toy's close resemblance to an actual laptop enables the user to understand and use many of the skills required to operate one. One category is included to specifically develop computer skills. Some of these programs require dragging and dropping objects with the mouse, for others the user must be

able to find and press buttons on the keyboard. The battle mode as well encourages different methods of computer use, and there is the timed clicking battle, where the user has to use hand-eye coordination to click the mouse at the exact moment. There is also the button-mashing battle mode, where they have to click the mouse button very fast in order to succeed. Even the power button functions similarly to that of a standard laptop.

Extending Knowledge of the World:

This criteria is also covered by many of the categories of programs, in particular the life category. The life category contains activities that relate to aspects of the real world, such as recognizing map and traffic signs, matching countries and their flags, telling the time, and even tidying the house. There is also the overall dinosaur theme and the encyclopedia, through which the user can find out a wealth of information about the Earth's past.

Developing Dispositions to Learn:

There are many methods of encouragement used to promote the user's willingness to learn with this toy. The main reward system first steers the user towards using the educational programs. Through practice and progress in these programs, the user gains points which can then be used to "level up" the dinosaur avatar the user is controlling through their customized mouse. These dinosaurs are then used in the battle mode, which rewards them with a new dinosaur fact sheet in the encyclopedia for a victory. This process utilizes instrumental motivation to encourage the children to prioritize learning so that they can achieve their goal of completing the encyclopedia (Gardner & MacIntyre, 1991). Many of the individual programs also help motivate learning through the "gamification" of the learning process (Kim et al., 2018). For example, the tidying game in the life category involves the user categorizing everyday household objects and then dragging them into the related repository such as socks into a drawer, or toys into a storage box. There is also the stamp rally, which the user also can complete through making progress in the educational programs.

Summary:

The Dinosaur Encyclopedia Laptop Computer has a wide range of different subjects, programs, and methods of play. It develops a range of skills, those involved in operating a laptop, as well as educational skills related to the different subjects. The reward system is very effective in keeping users motivated to keep using the device at least until their extrinsic goal of completing the dinosaur encyclopedia is achieved. It even has an alternative reward in the stamp rally, which is a very popular form of goal-orientated entertainment in Japan.

The dinosaur laptop does, however, have its limitations. Despite the wide breadth of categories of the

programs, many are quite superficial in content, and can be quickly completed by a competent older user. Also, in order to get the most out of the programs on offer, the user needs to be at the upper end of the age range, with a sufficient grasp of Japanese literacy skills. Younger users will enjoy playing, but some of the games will require some guided interaction or assistance from an older child or adult.

## CONCLUSIONS AND FURTHER RESEARCH

This study has drawn on literature in the field to show that the revolution in digital technology use is impacting pre-school age children under five just as much as it is influencing the practices of older children and adults. Consequently, it is crucial that the growing amount of digital toys, games and apps targeted at this age group be carefully evaluated. Our paper has focused on two examples of popular early years digital technology. From this study, we found that Plowman et al.'s (2012) framework is particularly useful for evaluating digital technology, whereas Wrench's (2001) evaluation criteria were found to be too technical to adequately evaluate the learning gained from the use of early years digital technology. The two pieces of software reviewed for this article offer a variety of different techniques, methods and subject material to motivate children to keep playing, and most importantly, to learn. Because both have easy-to-learn interfaces, they can be used by children of all ages and require guided interaction chiefly for initial interactions or the more complex aspects of the hardware itself. Both also personalize learning; *Kinect Sesame Street TV* by placing the children on screen with the characters, and the Dinosaur Encyclopedia Laptop Computer by letting children choose their favorite dinosaurs and increasing their level. They also appeal to multiple learning styles and offer a wide range of topics for students to experience.

This paper is only a small-scale focus on just two of hundreds of digital toys for the under-fives; as such it is difficult to get a representative overview of all the options available. As mentioned earlier, Section 2, Characteristics: Instructor Use from Wrench's Educational Software Evaluation Form (2001) was eliminated for the purposes of this article as neither piece of hardware nor accompanying software was tested in a classroom setting. Further research on the software above, or other software, will require their use by children in classrooms or other controlled settings. Such observations and recordings taken will accumulate more objective data and a wholistic evaluation of the software in question can then be performed. Information regarding outliers in data—children who perform particularly well, or conversely, those who underperform—can be followed up on to determine factors that may have influenced the results of such performances.

Further research into the effectiveness of each program could also involve an examination, though a child's knowledge and understanding of the concepts presented would be more difficult to evaluate than the hard numerical score given as the result of taking a test (such as TOEIC). Furthermore, it would have to be undertaken in such a way that the natural utilization of the software is uninhibited by the

anxiety or other negative feelings that may result from children being aware of such an examination.

Technology will no doubt continue to evolve, and with the emergence of virtual reality as a viable interface, perhaps it will not be long before educational VR programs can be created and evaluated for educational purposes.

Perhaps the virtual education planet in the OASIS is closer than we know.

## Notes

[1] A holodeck is a room in Star Trek that can recreate any environment, such as a classroom, forest, or baseball field, by creating electromagnetic holograms that look realistic and can be interacted with physically.

[2] A detailed evaluation using an abridged version of Wrench's Educational Software Evaluation Form (2001) can be found in Appendix 1.

[3] Minority Report is a 2002 science fiction movie that employs technology which holographically projects information that can be interacted with. *Kinect Sesame Street TV* would be a stepping-stone to this theoretical technology.

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Appendix 1: Wrench's Educational Software Evaluation Form as applied to Kinect Sesame Street TV for the Microsoft Xbox 360

Characteristics: Curriculum Content

| | | |
|---|---|---|
| 1. | This software would work with existing curriculum | 3/5 |
| 2. | Breadth of the content in the software | 3/5 |
| 3. | Depth of the content in the software | 4/5 |
| 4. | Software has clear learning objectives | 3.5/5 |
| 5. | Content can advance as the user (learner) advances | 1/5 |
| 6. | Age appropriate | 4/5 (for hardware, 5/5 for content) |
| 7. | Shows a diverse group of people | 5/5 |

Total Program Operation/Documentation Score: 23.5 (24.5) / 35

Characteristics: Instructor Use was eliminated for the purposes of this article as this software was not tested in a classroom setting.

Characteristics: Student Use

| | | |
|---|---|---|
| 1. | Requires no computer knowledge | 5/5 |
| 2. | Does not require the student to reference manuals | 5/5 |
| 3. | High student involvement | 5/5 |
| 4. | Provides students with a summary of performance | 3/5 |
| 5. | Shows no racial, sexual discrimination | 5/5 |
| 6. | Encourage (sic) cooperation | 2/5 |
| 7. | Student control over rate of presentation when appropriate | 3/5 |
| 8. | Length (time) of simulation is appropriate | 5/5 |
| 9. | Allows for students to cooperate with other students to complete the activities | 2/5 |
| 10. | This software allows students with different learning styles To be equally effective | 5/5 |

Total Characteristics: Student Use Score: 40/50

Characteristics: Program Operation and Documentation was excluded from this review as the interface and menus are very simple and easy to navigate.

Publisher Information has also been excluded as that would require more research and interviews outside of the scope of this article.