

# Curriculum and design analysis of a mathematics-based educational television program: a case study of Cyberchase animated television series

Farrah Dina Yusop [1]

[1] Faculty of Education  
University of Malaya  
Kuala Lumpur, Malaysia  
farah@um.edu.my

## ABSTRACT

This paper presents a curriculum and design analyses of an Emmy-award winning children educational television series, Cyberchase. Using Posner's (2004) four process of curriculum analysis framework, this paper addresses each of the components and relates it to the design principles undertaken by the Cyberchase production team. Media and document analysis techniques were used to examine selected samples of the series. Findings indicate that the series succeed in teaching mathematical concepts, generate interest in mathematics learning and assist in development of mathematical problem-solving skills. This paper may provide information on how the series effectively used multimedia elements to deliver serious academic content in the most entertaining ways.

**Keywords:** *Curriculum analysis framework, media and document analysis techniques*

## INTRODUCTION

Research on educational television programs reveal that children are likely to favor educational programs embedded with social-emotional themes as opposed to purely academic focus (Calvert & Kotler, 2003). However, quite contrary to these findings, Cyberchase, an Emmy award winning (Donlevy, 2004; Olsen, 2006) animated series with strong focus in academic content namely, Mathematics, Science and Technology has been found to continuously win children's hearts since it is first aired in 2001.

This paper intends to unmask the unique design features of the series that make it well-accepted by children in United States. The first part of this paper discusses Schwab's (1978) conceptions of curriculum. The second part of this paper argues that Cyberchase as a curriculum provides a valuable tool to support informal and non-formal Mathematics learning through articulation of children's problem solving and creative thinking skills in entertaining ways. The third part of the paper highlights in detail the analysis of the series based on Posner's (2004) "Process of Analyzing Curriculum" framework featuring four set of components: the curriculum documentation and origins, the curriculum proper, the curriculum in use, and the curriculum critique. The next section will introduce Cyberchase to set the stage for further discussion.

## INTRODUCTION TO CYBERCHASE: LEARNING THROUGH MEDIA AND TECHNOLOGY

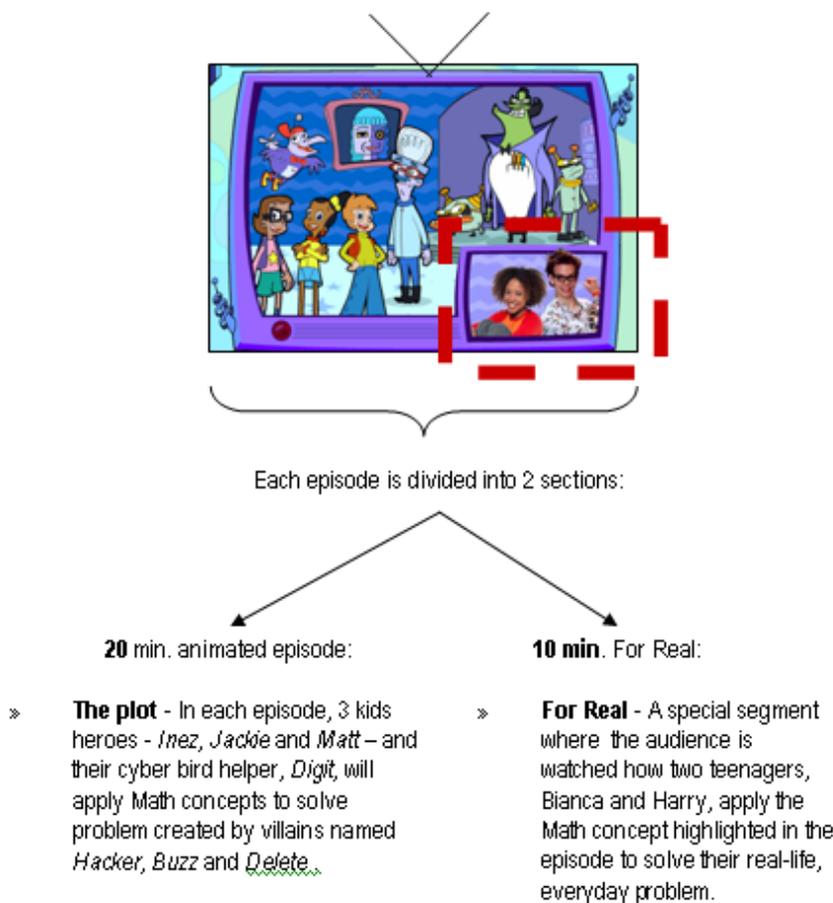
Cyberchase is a Mathematics-driven animated television series designed for children ages eight to twelve years old. The program is funded by the National Science Foundation (NSF) of the United States under the "Informal Science Education" category, among other major funding agencies (Cyberchase, 2012). The Cyberchase series are produced by the Thirteen/WNET New York and Nelvana International. It is broadcasted daily on 340 Public Broadcasting System (PBS) stations in the United States since 2001 (Cyberchase, 2012) and are estimated to reach "approximately 91% of US television households" (Donlevy, 2004). The series were originally focused on introducing Mathematics concepts

alone, but later on integrated Science and Technology content into it. This addition makes it an excellent multimedia-based educational tool for teaching and learning Science, Technology and Mathematics (STEM). Only the mathematical content of the series will be analyzed and discussed in this paper.

The series are designed to introduce and engage its targeted young viewers with application of critical thinking and problem-solving skills using variety of Mathematical concepts. It features three young children about the same age as the target audiences – Inez, Jackie and Matt - and their cyber bird helper, Digit, working together to solve problems caused by a villain named Hacker and his two assistants, Buzz and Delete. However, they need to apply Mathematical concepts and skills in order to save the planet since Hacker is very good at capitalizing on his Mathematical knowledge and skills to cause the planet’s destructions.

Each episode of Cyberchase is followed by a special segment called *For Real*. In this five to ten minute segment, viewers are presented with the real-world application of the Mathematical knowledge and skills presented and taught earlier in the episode. In this segment, the viewers will follow through a real-life scenario or dilemma experienced Bianca and Harry, stars of the segment, in their everyday lives that requires the application of the Mathematics concepts highlighted in the episode. This segment is one of the important components of the television series as it assists in scaffolding children to view Mathematics knowledge and skills as practical and contextual-based concepts. Figure 1 presents the organizational structure of the series.

**Organization of CyberChase TV show**



**Figure 1: The organization of CyberChase TV show**

**METHODS OF ANALYSIS**

Working from qualitative research mode of inquiry, the main methods used in this study are observations, media and document analyses. The researcher watched and observed selected episodes from the Cyberchase series within 4 weeks time. The series are thus selected based on the specific themes addressed within the 4 weeks time. For each episode, the researcher took notes on its structure, timeline, instructional objectives and storyline.

Observational data are triangulated with data from media and document analyses. Specifically, the researcher collected and analyzed information on the television series that are available on the series' website (<http://pbskids.org/Cyberchase>). Two sections are of importance – the “About us” and “Parents and Teachers” sections. The first provides information about the mission and philosophy of the series, and the later section explains the objectives of each of the episode and suggested ideas on how parents and teachers could use them to expand Mathematics-based discussions and learning with their children at home and schools. Other supplemental information includes the advertisements related to Cyberchase series in journals and publications, research papers published by the series' independent consultants, information from the National Science Foundation (NSF) website regarding the purpose, history and any other relevant information related to the series.

The next section presents the analyses of Cyberchase. It is divided into two (2) parts. The first part argues for the justification of Cyberchase as a curriculum based on Schwab's (1978) conception of curriculum and curriculum making processes. The second presents detail analyses of Cyberchase as a curriculum based on Posner's (2004) framework of analysis.

### **Part 1: Cyberchase as a curriculum**

Schwab (1978) argues for the needs to have representatives of five bodies of learning experiences – or what he refers to as “four commonplaces of curriculum” – in the process of curriculum design and development. They are:

#### *Teachers*

It is important for any curriculum development group to have knowledge of teacher perspectives, characteristics, readiness, knowledge of the curriculum content and appropriate skills to deliver the content. This is to ensure that teachers are ready to implement the designed curriculum in their classrooms. If teachers are not quite ready, there are needs to conduct relevant trainings, for instance, for them prior to implementing the planned changes.

#### *Learners*

It is also essential to have knowledge about the learners who are going to be affected by the curriculum. Information such as their age group, prior knowledge and skills, and attitudes towards the curriculum will be helpful in designing and developing curriculum.

#### *Milieus*

Milieus refer to the general situations in which the curriculum is planned to be implemented. This includes locations such as school and classroom, as well social and cultural nature surrounding the learners, for instance the neighborhood area which the curriculum will be enacted. Knowledge of where the curriculum and learning will take place is important to allow for curriculum modifications to suit the learners' needs. For example, curriculum that requires learners to collect data online may not be suitable to be enacted at a school where the learners do not have access to Internet.

#### *Subject matter*

Knowledge of the subject matter or curriculum content is essential. There must be someone in the curriculum design and development team who is considered an expert of the content. This expert will advise the team on the key concepts need to be learned, how best the content can be taught and should be delivered, and how it can be assessed.

#### *Curriculum making*

In addition to the four commonplaces, Schwab (1978) argues for the need to have someone to coordinate and oversee the overall aspects of curriculum design and development. This person, usually known as curriculum specialist, is also responsible to decide over any issues arise with his best knowledge.

### **Representation of Schwab's (1978) five bodies of learning experiences in Cyberchase**

The Cyberchase series are both seen as a multimedia-based educational tool and a curriculum. It is a powerful tool to support informal learning experiences, define here as unofficial and unscheduled learning experiences that occur beyond physical classroom and school compounds, and often occurs in impromptu way (Cross, 2006).

There are three (3) teams involved in CyberChase series production: the content expert team, the multimedia team and the curriculum specialist team. The content expert team consists of one Mathematics education and one informal science education experts. Other members include researchers and teachers of both Mathematics and science education. The members decide which content to be highlighted in each episode and link it with the mathematical standards used in teaching Mathematics in the United States. Members in the multimedia team are responsible with designing, creating and producing the Cyberchase television series. They are the television producer, website producer, actors and actresses behind the scene. Finally, members of the curriculum specialist team include members of the National Advisory Board external reviewers such as the funding agencies and independent multimedia research consultant. Both the National Advisory Board and external reviewers can be considered as the stakeholders of the series. The independent consultant, on the other hand, is responsible to conduct various research studies on the impact of the series on children's mathematical thinking and attitudes toward mathematics and evaluation of the series website and outreach components in schools and in the community, among others.

The three teams of Cyberchase are representatives of all five bodies of learning experiences defined by Schwab (1978) – the teacher, learner, milieu, subject matter and curriculum making.

#### *Teachers*

The CyberChase production team consists of teachers and curriculum experts who understand the teachers' needs, characteristics, working nature and readiness to implement the curriculum. The team meets frequently with other teams such as instructional designers and animators to discuss on the content of the next episodes.

#### *Learners*

Learners' perspectives are represented by the teachers and curriculum experts in the team as well. As teachers, they are able to identify their learners' prior knowledge on the content and other information helpful for the creation of each episode.

#### *Milieu*

Because the Cyberchase series are broadcasted via television cables, learners residing at any locations from variety of socio-economic backgrounds have access to it, provided they have the technologies at home. Additionally some of the series are available online in the form of video clips, too, which allow learning to occur at anytime in anyplace. Thus the milieu in the Cyberchase series are considered to be the broadcasting technologies and the Internet.

#### *Subject matter*

The content expert team includes Carey Bolster, a well-known former teacher, an expert and a textbook author of Mathematics, and Michael Templeton, an expert of informal science education, among others. Together with other members of the content expert team, they will ensure that the content of each episode is tailored to the Mathematics standards utilized in the United States. Once the content is determined, the team will then discuss the appropriate storyline for the episode. The multimedia team will then transform their ideas into series format.

#### *Curriculum making*

The process of making the curriculum is of collaborative effort among the three teams. They are actively engaged in designing, creating, testing and involve in every aspect of curriculum making decisions. Once the content and storyline have been agreed upon, the producers of the series will proceed with the process of making the curriculum i.e. the series available for viewing.

Table 1 below presents summary of how Schwab’s (1978) five bodies of learning experiences is represented in Cyberchase.

**Table 1 Schwab’s (Schwab, 1978b) five bodies of learning experiences and its representations in the Cyberchase television program**

Schwab’s five bodies of learning experiences	Descriptions	Representation of Schwab’s five bodies of learning experiences in Cyberchase
1. Teacher	“Knowledge of the teachers, including teachers’ knowledge, characteristics, personalities, readiness to learn new materials and new ways of teaching” (Schwab, 1978b, p.367)	The CyberChase production team consists of teachers and curriculum experts who understand the teachers’ perspectives and the Mathematics curriculum.
2. Learner	“Knowledge about the learners, divided into two: (1) knowledge about the learners’ present state of mind and heart, including the age group, prior knowledge, readiness to learn, aspirations and anxiety, and (2) knowledge about the learners’ development towards being an adult” (Schwab, 1978b, p.366)	Learners’ perspectives are represented by the teachers and curriculum experts in the team as well.
3. Milieus	The milieus of which the child’s learning will take place and “in which its fruits will be brought to bear” including the school and classroom of which learning is supposed to occur, the child’s interaction with the family, community, and particular groupings of religious, class or ethnic genus (Schwab, 1978b, p.367).	The Cyberchase series are always available for learners residing at any locations and from various socio-economic backgrounds. The series are also available online, downloadable from its website. This allows learning to occur at anytime in anyplace.
4. Subject matter	“Knowledge about the content and area of learning” (Schwab, 1978b, p.367)	The content experts determine the content to be covered in each episode based on the Mathematical standards used in the United States. Recently Science and Technology Education have also been included in the Cyberchase series.
5. Curriculum making	“Knowledge on managing the process of curriculum making among the four bodies of representation of learning experiences: teacher, learner, milieus and subject matter” (Schwab, 1978b, p.367).	Members of the Cyberchase production team are actively engaged in designing, creating, testing and involve in every aspect of curriculum making decisions.

**Part 2: Curriculum analysis of CyberChase series**

This paper follows Posner’s (2004) framework of curriculum analysis in analyzing the design and curriculum of the Cyberchase series. Expanding from Tyler’s (1949) Rationales for Curriculum Planning, Posner (2004) suggests four sets of curriculum analysis processes: (1) analysis of the curriculum documentation and origins, (2) analysis of the curriculum proper, (3) analysis of the curriculum in use, and (4) the curriculum critique. Each of this component is presented below, followed by detail analyses of the series.

*Curriculum documentation and origins*

This first set of Posner’s (2004) analysis refers to the political, economical and social problems that prompted the formulation of the curriculum. For instance, the emerging need to educate students to be computer literate

becomes the basis of computer literacy curriculum (Posner, 2004). It is important to know the history behind formulation of a curriculum so as to allow educationists to review the curriculum if needed.

*Curriculum proper*

The second set of Posner’s (2004) curriculum evaluation framework, *curriculum proper*, is meant to capture the essence of the curriculum. It zooms into the process of designing and developing the curriculum by examining the purposes and content of the curriculum, and how it is organized.

Examination of curriculum purposes and content require close examination of its educational aims, goals and down to its learning objectives. Organization of the curriculum, on the other hand, is concerned with the epistemological views applied in its content organization. Posner (2004) identifies two sets of views that affect curriculum organization: the behavioral psychologists view and the cognitive psychologists view. The first view is concerned with change in certain behaviors of the learners, while the later is concerned with enhancement of the intellectual abilities such as higher-order thinking skills of the learners.

*Curriculum in use*

The third set of the analysis, curriculum in use, refers to the issue of curriculum implementation and evaluation. Some of the issues one needs to consider include the issue of available resources and the constraints emerged resulting from the implementation of the curriculum. Examples are the challenges with the technologies needed to implement the curriculum, the knowledge and skills of people responsible to implement the curriculum e.g. school librarians, teachers and parents, and physical layout of the classrooms where the curriculum is implemented.

*Curriculum critique*

Curriculum critique, the fourth set of Posner’s (2004) analysis framework, concerns with the strengths and limitations of the curriculum that may lead to its re-making. Such analyses will also shed some lights on maximizing its strengths and minimizing its limitations.

Each of these components contains a set of questions that guide the curriculum analysis. The set of questions relevant to this study is represented in Table 2 below.

**Table 2: Posner’s (2004) framework on curriculum analysis**

Component(s)	Questions
Curriculum documentation and origins	How is the curriculum documented? What situation resulted in the development of the curriculum? What perspectives does the curriculum represent?
Curriculum proper	What are the purposes and content of the curriculum? How is the curriculum organized?
Curriculum in use	How should the curriculum be implemented? What can be learned from an evaluation of the curriculum?
Curriculum critique	What are the curriculum’s strengths and limitations?

**Analyses of Cyberchase series based on Posner’s (2004) framework**

Media and content analyses of Cyberchase revealed that this television series has the potential to become an effective educational multimedia tool for Mathematics learning especially for the elementary school learners. The major contribution of this series is its ability to connect Mathematics to everyday living experiences which allows children to see the real-world application of Mathematical concepts and principles beyond classroom walls. This section presents findings of the analyses based on Posner’s (2004) curriculum evaluation framework.

**Component 1: Curriculum documentation and origins**

While the driving forces behind Cyberchase series are not explicitly mentioned either in its website or in the literature reviewed, it is believed that its existence is related to respond to the worldwide demands for more efficient ways in teaching and learning mathematics in the United States and elsewhere. Additionally there are other influential political forces that may explain the driving forces of Cyberchase series: (1) the Children’s Television Act 1990, and (2) the Public Broadcasting Act 1967.

### The Public Broadcasting Act 1967 and the Children's Television Act 1990

In the early days of the introduction of television in the United States, children's educational television programs were only part of the standard commercial offerings (Huston and Wright, 1998) which did not support the public informational and educational needs of all age group (Kunkel and Watkins, 1987 quoted in Huston and Wright, 1998). As a result, non-profit, public broadcasting system in the United States was established under the Public Broadcasting Act 1967 (Kunkel and Watkins, 1987).

The establishment of the public broadcasting system had encouraged an effort by a consortium of educators, creative artists, and others to launch *Sesame Street* television program, aimed to reduce the risk of school failure among the urban, poor, minority populations in the mid 1960s (Huston and Wright, 1998). The program was well received not only by the target populations, but also attracted other group from different income and ethnic groups (Zill, Davies and Daly, 1994 quoted in Huston and Wright, 1998). Since the success of *Sesame Street*, the amount of children's television programming had increased. Some of the pushing factors were due to the federal support for such programs through the Equal Educational Opportunity funds.

The success of *Sesame Street* together with the public needshave bolstered the establishment of the Children's Television Act 1990 under the President George Bush administration (Anderson, 1998). The CTA law requires that broadcast television stations need to provide minimal amount of educational and informative program for children as a public service condition for license renewal (Anderson, 1998). In the case of CyberChase, it is assumed that both the CTA and PBA laws had major influence on the production of CyberChase, besides the needs to reform the Mathematics education.

Analyses of the television series revealed that each of Cyberchase episode is aligned with the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics Grades 3 to 5 (NCTM, 2004), a widely referred standard in teaching Mathematics in the United States produced by an independent professional body. Specifically, the CyberChase series apply the NCTM's Principles and Standards for School Mathematics for Grades 3-5 as their target audience are children ages 8-11 years old. The organization of NCTM's Principles and Standards for School Mathematics is presented in Figure 2 below.

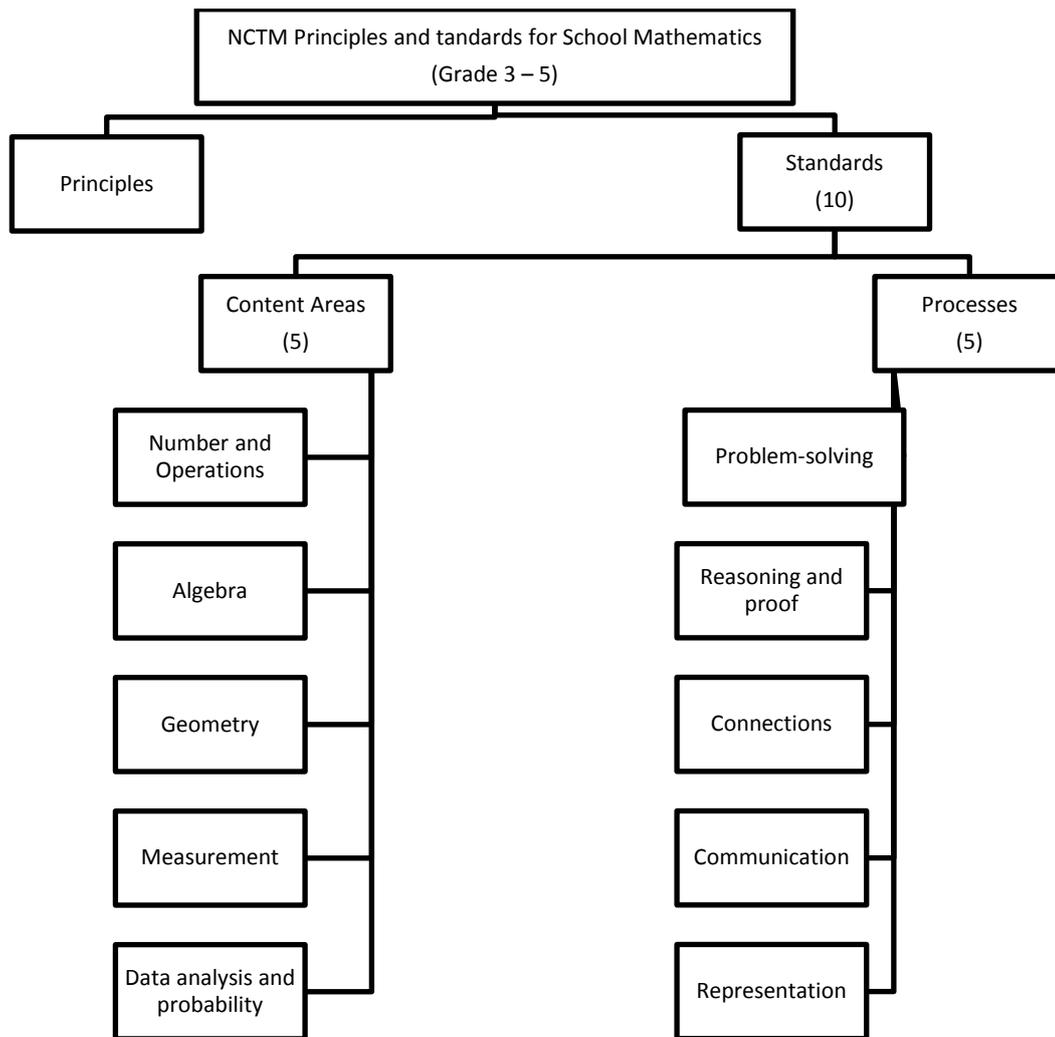


Figure 2 The organization of NCTM's Principles and Standards for School Mathematics. Adapted from the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics Grades 3 to 5 (NCTM, 2004)

Each Cyberchase episode features one *Big Idea* which is linked to one of the NCTM's Expectations in a specific Math content area. For example, the *Big Idea* for episode 203 *Harry Hippo and the Mean Green* is "Fractions that look different can represent the same portion of a whole" (Cyberchase, 2012). This *Big Idea* is similar and linked to NCTM's objectives of the "Numbers and Operations" content area.

Additionally, each episode in the series is designed based on Cyberchase educational philosophy that "Math is everywhere and everybody can be good at it" (Cyberchase, 2012). The philosophy infuses an essential hidden curriculum, the idea that there are always Mathematical concepts and procedures that the children can apply to solve emerging problems in their daily lives. By observing how the characters brainstorm ideas, gather important information, and apply Mathematical procedures to save their planet, the children too are scaffolded to think and act like the characters.

The series also wisely instills many positive attitudes to the children through the characters' interactions with each other. They learn to respect, appreciate and learn from each others' strengths and weaknesses. In episode 202 *Totally Rad*, for instance, one of the characters, Matt, almost loses a skate-off competition because of changes in the perimeter of the skating area caused by Hacker. Knowing that he would never be able to win the competition, Matt began to give up but his friends, Jackie and Inez, kept on encouraging him to continue with the competition. Inez in particular motivates Matt by saying, "That doesn't mean you have to give up, Matt. Team Motherboard never gives up!" (Cyberchase, 2012). After learning about the concept of perimeter, the characters brainstorm on the ways Matt should skate to win it.

### Component 2: Curriculum proper

It is apparent that the series are designed and delivered from both cognitivist and social constructivist point of views. While the core content of Cyberchase is Mathematics, the series also integrate Science and Technology content into its episodes. In each episode, viewers are presented with specific mathematical problems that challenge them to apply their prior mathematical knowledge and skills. This problem-solving approach to content delivery is aligned with the cognitivist view, but are delivered to the targeted audience in entertaining and fun ways that most of its viewers may not aware of the actual desired lessons built in each of the episode.

Additionally, the series highlight and acknowledge the socio-emotional aspects experienced by the characters such as the importance of collaborative work, the need to respect and complement each other's perspectives, strengths and weaknesses and so forth. These values are repetitively shown in each episode and each of the characters seems to take turn experiencing challenging moments that call for learners' memory that hopefully will be internalized and later, practiced, by the viewers.

An interesting feature of the series is the additional segment at the end of the series designed to ensure that the learning content more explicit to the learners. This five to ten minute segment, *For Real*, features two teenage stars, Harry and Bianca who face a real-life everyday problem that can only be solved using specific Mathematical content taught earlier in the episode. For instance, to further enhance children's understanding of the concept of fractions in the episode 203 Harry the Hippo and the Mean Green, the children are presented with a *For Real* segment called *Bianca's New Pet* in which Bianca needs to figure out how different pieces and sizes of woods can make up a whole roof for her doghouse. This situation strengthens children's prior learning on equivalent fractions featured in the 203 Harry the Hippo and the Mean Green episode.

### Component 3: Curriculum in use

This study concluded that Cyberchase television series are capable of being a tool to expand Mathematics learning beyond classroom walls. Besides the animated series, learning continues to be supported with Cyberchase website. The website not only provides basic information about the television program and its characters, but also supply free entertaining Mathematics-related educational games for children, educational materials and resources related to the episodes (Donlevy, 2004).

Of particular interest is a special section designed for teachers that include practical suggestions and instructional materials on how to reinforce students' learning of a mathematical content related to an episode. For instance, the *Castle Blanca* episode focuses on the sampling and surveying techniques to gather data. This episode is coupled with detail step-by-step activities, video clip from the episode, handouts to be used during the activities and assessment sheets to assess children's knowledge about the content. All of these materials are available through the PBS Learning Media website at <http://www.pbslearningmedia.org>. Most recently, these materials and applications are also available for a very small fee to be used with iPhone, iPad, and SmartBoard in and outside of classrooms.

To ensure that children's love for Mathematics learning continues, another section for parents is developed. This section educates parents about the Cyberchase series and offers tips to expand Mathematics learning at home. For example, there is a sub-section in the website that offers parents practical ideas on how to throw a Cyberchase-based birthday parties using Cyberchase materials from the invitation cards, to party activities, decorations and party supplies <http://www.pbs.org/parents/birthdayparties/Cyberchase>. All of these tools enabled Cyberchase to be considered as a community engagement tool.

### Component 4: Curriculum critique

The Cyberchase series have received numerous positive responses from children, parents and teachers. Studies conducted by external parties have shown that the series positively impact children's mathematical problem-solving skills (S.M Fisch, 2003) and generate excitements in mathematics learning during outreach programs (S.M. Fisch, 2007; Flagg, 2003).

Despite of these responses, however, there is small concern related to its availability to wider audiences. Since the series are aired via Public Broadcasting System (PBS) stations, it reaches only to limited number of viewers compared to other commercial network stations such as Cartoon Network or Disney Channel. Hence it will be advisable for the production team to think of promoting the series via these large, commercial stations, too.

Another concern is regarding the underutilization of this television series as a learning tool integrated within current curriculum in schools. Analysis of various research reports conducted by a group of independent researchers,

such as Flagg (2003) as well as analysis of multimedia resources on the use of Cyberchase series among teachers revealed that application of these series is limited to out-of-school programs. These results indirectly imply that Cyberchase series function as supplemental instructional aids in Mathematics teaching in spite of its valuable features and potentials to be one of the most effective learning tools for children. Perhaps one of the reasons is due to the lack of exposure among educators and parents about what the series is all about and how it is designed to meet National Council of Teachers of Mathematics (NCTM) standards and principles. Another reason could be due to limited access to technologies such as television and Internet in certain schools, especially among socially and economically disadvantaged neighborhoods throughout United States.

## CONCLUSION

This study presents design and curriculum analysis of one the most popular animated educational television series, Cyberchase, based on Posner's (2004) analysis framework. Findings indicate that the series is a powerful media for children to learn Mathematics in an entertaining ways, inside and outside schools. In addition, this study also reveals the potential of Cyberchase television series to be an effective Mathematics learning tool along with other learning tools by decomposing the principles that guidance each design and development of the series.

It is hoped that by unmasking the design ideas behind its production, more educators and parents will discover the advantages of using Cyberchase television series for Mathematics instruction and to be able to integrate it into current in-school (not just after-school) teaching and learning settings along with the official and operational curriculum they implemented in the classroom.

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