AASL

Exploring Graphic Novels for Elementary Science and Mathematics

Suzanne Nesmith, Assistant Professor, Baylor University School of Education, Curriculum and Instruction, Waco, Texas

Sandi Cooper, Associate Professor, Baylor University School of Education, Curriculum and Instruction, Waco, Texas

Gretchen Schwarz, Professor, Baylor University School of Education, Curriculum and Instruction, Waco, Texas

Prompted by the recent surge in the popularity and utilization of graphic novels in the elementary classroom as well as trends toward the publication of content-focused graphic novels, the research described in this study was designed to explore educators' perspectives toward the medium as well as the issue of quality in graphic novels with science or math content. Qualitative results recorded through evaluation forms and focus-group sessions revealed the existence of variance in participants' perspectives. However, these results also indicate potential benefits and perceived problems or concerns.

Graphic novels, the longer and more serious offspring of the comic book, have received growing attention by educators. Hall (2011), preparing to teach college courses in comics, declares that "comic books and graphic novels are one of the newest fully fledged art forms, a vibrant hybrid medium birthed in American and brimming with all the wildly experimental vigor of youth" (39). Indeed, educators have argued for graphic novels in the English classroom for teaching social issues (Tabachnik 2009), for ESL students learning English (Boatright 2010), and even for science-math instruction at the elementary through middle school level (Chipman 2010). A growing number of educational publishers, like Scholastic, have begun to create graphic novels for students of all ages with a focus on a wide range of content areas. As interest and the number of published graphic novels grow, however, questions of classroom utilization and textual quality grow as well. All graphic novels are not appropriate for all teachers, nor are these appropriate in all classrooms and for all content areas. Concerns relevant to both the content and literary value are valid because, as with children's literature across the curriculum, graphic novels across the curriculum are not all the best resources for teachers or students. Prompted by the recent surge in the popularity and utilization of graphic novels in the elementary classroom as well as trends toward the publication of content-focused graphic novels, the research described in this pilot study was designed to explore educators' perspectives toward the medium in general as well as their specific viewpoints relative to mathematics and science-focused graphic novels.

The tradition of using trade books, non-textbooks, in the elementary classroom is an old one. Authentic children's literature has long had a regular place in the elementary classroom in the area of reading and language arts. Increasingly, educators also have used trade books for other content areas, and the notion of integrating children's literature across the curriculum, whether through thematic units or other approaches, has become a standard idea (O'Callaghan 2011; Yellin, Blake, and DeVries 2000). Leitze (1997) cites the National Council of Teachers of Mathematics (NCTM) Standards as encouraging mathematics integration through children's literature and demonstrates ways that process problem-solving and literature can be connected. Evans, Leija, and Falkner (2001) specifically address teaching the NCTM mathematics standards through children's literature. Murphy (2000) argues that children's books about mathematics provide opportunities for children with different learning styles. Likewise, Morrison and Young (2008) argue that scientific inquiry can be aided by science trade books. Atkinson, Matusevich, and Huber (2009) offer a rubric for teachers to use in choosing science trade books for elementary classrooms. Naturally, as graphic novels gain a presence in the classroom, teachers also will be interested in using them in science and mathematics.

Not all children's literature is equal. A number of scholars have examined the issue of quality in children's literature, in particular trade books for science and mathematics. Is the content accurate? Does the story engage students? Are pictures informative? Such questions must be asked. Rice (2002) maintains that trade books can help the science curriculum if teachers are careful in their selections. Hellwig, Monroe, and Jacobs (2000) provide a framework for evaluating picture books related to mathematics. Whitin and Whitin (2001) declare that beautiful language also is an aspect of quality

literature that relates to mathematics. Nesmith and Cooper (2010) investigate the use of a mathematics trade book evaluation instrument because beneficial children's literature must be high quality. Likewise, not all graphic novels are equal, and as they become more frequently used in the classroom, quality becomes a vital question. Most of the research on graphic novels in the classroom has taken place at the secondary-college level (Carter 2007; Frey and Fisher 2008; Tabachnik 2009). Even in the area of college business, Short and Reeves (2009) explore the use of graphic novels for communicating content. Understandably, most graphic novels have been written for adolescent and adult audiences. However, graphic novels are beginning to appear in the professional literature for the elementary classroom. Librarians have been at the forefront advocating and recommending certain graphic novels (Gorman 2008; Teale, Kim, and Boerman-Cornell 2008). Although publications like *Booklist* offer short reviews, and Guiterrez (2009) describes the wealth of good new graphic novels for K–4 in *School Library Journal*, a need remains for study of quality in graphic novels. When this need is examined alongside the recent emergence of elementary-focused, content-specific graphic novels, it becomes important for educators, from classroom teachers to librarians, to have access to valid review sources or (in the absence of suitable reviews) that they are afforded a means for self-reviewing graphic novels. As Schwarz (2009) argues, graphic novels can be published that are worthless but might sell well: "Not all graphic novels are thoughtful or even necessary" (10).

In an effort to learn more about educators' perspectives toward graphic novels and their utilization in elementary mathematics and science classrooms, the following study was organized. Two questions provided guidance for the study:

1. What are the educators' perspectives on the utilization of graphic novels in the elementary classroom?
2. What are educators' perspectives on utilizing mathematics- and science-content-focused graphic novels in the elementary classroom?

Participants

Because we were interested in exploring educators' perspectives toward the utilization of graphic novels in the elementary classroom while also examining these educators' perspectives toward mathematics- and science-content-focused graphic novels, we elected to invite elementary classroom educators as well as elementary teacher educators to participate in the study. Seeking to incorporate as much participant variance as possible while still maintaining study manageability, a determination was made to include 11 participants. Seven participants were currently teaching in elementary classrooms within local school districts, and four of the participants held faculty positions within the university's department of curriculum and instruction. Faculty members were purposefully chosen and included the director of the Learning Resource Center (a librarian), an elementary literacy educator, an elementary science educator, and a middle-level mathematics educator. Purposeful sampling also was utilized in choosing classroom teacher participants. All classroom teachers were chosen on the basis of their experiences as elementary educators as well as their expertise in elementary literacy, mathematics, and science. These determinations were made on the basis of the participants' years in the classroom and by their previous interactions with the researchers. It is important to note that while in the midst of the research, the middle-level mathematics teacher educator asked to be removed from the study because of personal reasons, and all subsequent data reflects information garnered from the 10 remaining participants.

Trade Book Determinations

Trade books were selected for the study with determinations made on the basis of simple current availability (what has been published) and a desire to have a diverse sampling of textual structures and formats as well as an equal number of mathematics- and science-content-focused texts. Wanting to incorporate as many trade books as possible with as much variance as possible while still maintaining study manageability, it was determined that six trade books would be incorporated in the study. The three chosen mathematics graphic novels included *The Mystery of Nine* (Law and Way 2010), *The Math Game I* (Jung, Chung, and Spoor 2005), and *Math Mysteries—The Secret Ghost* (Thielbar and Ota 2010). The three chosen science graphic novels included *A Journey into the Human Body* (Oh 2005), *Einstein* (Special Academic Manga/Ykids 2007), and *The Shocking World of Electricity* (O'Donnell et al. 2007).

Developing a Guide for Review

As noted previously, a lack of resources designed to guide educators' recognition of quality graphic novels exists, specifically graphic novels that are focused on mathematics and science content. Recognizing this lack, while also desiring to explore educators' perspectives toward mathematics- and science-focused graphic novels, a determination was made by the researchers to create a guide for participants to use when reviewing the graphic novels chosen for the study.

Numerous criteria and formats have been created and utilized for the examination of children's literature. When the literature is content-focused, the development of a guide for reviewing the literature takes on additional depth and complexity because of the necessity in determining those elements that constitute quality content. In designing a guide for reviewing mathematics- and science-content-focused graphic novels, quality criteria associated with mathematics content, science content, literary content, and graphic novel content were each considered separately. Schiro (1997) constructed an evaluation instrument for the evaluation of mathematics-focused literature, and this instrument was later revised by Hunsader (2004). While Schiro's instrument consisted of 11 mathematics criteria and 11 literary criteria, Hunsader's adaptations reduced this to 6 mathematics criteria and 6 literary criteria. Hunsader's mathematics-evaluation criteria include (1) content accuracy; (2) content visibility; (3) developmental appropriateness of content for the book's stated audience; (4) facilitation of the reader's involvement in, use of, and transfer of the content; (5) complement between the story and the mathematics in the story; and (6) resources required for the reader to obtain the maximum benefits of the literature. Specific literary criteria within the Hunsader instrument include (1) plot/character development, (2) vivid and interesting writing style, (3) relevancy and appeal of illustrations, (4) developmental appropriateness of readability and interest level for the book's stated audience, (5) complement between the book's plot, style, and illustrations, and (6) presentation of positive ethical and cultural values. Subsequently, the design of Hunsader's revised instrument as well as much of the instrument's mathematics and literary criteria were used in formulating the mathematics and science graphic novel review guide designed specifically for this study. Additionally, and again because of the distinct nature of this study, elements specific to graphic novels were integrated within Hunsader's literary criteria and include the following: To criteria 1 was added "are the characters (if any) believable and well developed?" and to criteria 3 and 5 the term "graphics" was added. However, it is noted that the qualities that constitute quality in a graphic novel remain fairly vague in the literature. Critics share their opinions, and many agree on the complexity of the graphic novel (Crutcher 2011). Perhaps artist Eddie Campbell (2007) says it best when he describes graphic novels as "an emerging new literature of our times in which word, picture, and typography interact meaningfully and which is in tune with the complexity of modern life with its babble of signs and symbols and stimuli" (13). Certainly, developed plot and character, engaging writing style, engaging pictures, developmental appropriateness, and the ways style and pictures work together are good standards to begin with when exploring the quality of graphic novels.

Development of the science criteria utilized in the review guide involved the examination and compilation of numerous researchers' suggestions of criteria to be used when evaluating children's books for science instruction. Based on the work of Mayer (1995), Rice (2002), Owens (2003), and Halsey and Elliott (2007), a determination was made to include the following science standards in the study's graphic novel review guide: (1) content is accurate and current, (2) content is visible and effectively presented, (3) content is intellectually and developmentally appropriate for the intended audience, (4) text facilitates reader's involvement, understanding, or transfer of science content, (5) theories and facts are easily distinguished and discernable from fiction or fantasy, and (6) text promotes a positive attitude toward science and technology.

Subsequently, the resultant mathematics and science graphic novel review guide contains six mathematics standards, six science standards, and six literary standards for graphic novels (see **appendix A**). Although the study's mathematics and science graphic novel review guide (as well as most of the previously cited content-specific literature evaluation tools) contains a five-point Likert scale for each of the listed criteria, participants' criterion ratings were utilized to guide and inform participants' subsequent participation in the study's focus group discussion.

Conducting the Study

To accommodate the needs of the participants, two group sessions were conducted. Participants were allowed to choose their session, and, subsequently, the sessions consisted of a mixture of classroom teachers and university teacher educators with six participants in one session and four participants in the other session. Both sessions occurred on the university campus, and all three researchers were present for the sessions. Reviewers were given the set of the six trade books, six corresponding review guides, and a brief overview of the intent of the study. Participants were encouraged to include as many comments as possible to provide rationale for the criterion ratings provided on their individual review forms. After sufficient time was provided for the completion of all six review guides, the participants were asked to contribute their perspectives, beliefs, and evaluative thoughts during a focus group session facilitated by the researchers. The same

protocol was utilized for both focus group sessions, and the sessions were audio and video recorded to capture the details of the discussion (see **appendix B**). The completed review guides were collected and organized, and the audio/video recordings of the focus group sessions were transcribed for analysis.

Data Analysis

The qualitative data analysis method of Miles and Huberman (1994) was used to analyze the transcribed focus group sessions and the written comments from participants' completed review guides. This narrative data set was first analyzed individually by the researchers to identify common patterns and themes using the research questions as a reference. The researchers then verified the coding structure through discussion and categorization of the data set, with theme designations made on the basis of the identification of at least two out of three researchers. The next level of analysis involved the organization of statements from the data set into the identified themes and each was verified by all three researchers.

Three major areas of ideas emerged from the two focus groups and from participants' comments on the mathematics and science graphic novel review guide. Generally, the teachers were hesitant but curious about the medium of the graphic novel: they recognized a number of potential benefits, and they perceived possible problems and concerns associated with using mathematics- and science-focused graphic novels in the elementary classroom.

Although one teacher explained that graphic novels were "just not what I prefer to read," she and the rest of the teachers expressed varying degrees of interest in this medium. They acknowledged that many students are attracted by graphic novels, although one mentioned that he wanted to know more about what "kids think." They struggled with defining just what graphic novels are ("like a comic book or video game"), how they connect to anime, TV serials, and other media, and if they can include nonfiction. Most important was the question "is it real literature?" Like any medium new to the classroom, the graphic novel will understandably face resistance and hesitance even as a few "early adopters" embrace the medium. Teachers will apparently ask if a new medium, especially one associated with out-of-school entertainment, is worthy of classroom use.

Nevertheless, the teachers also recognized a number of potential benefits to using graphic novels as an option in school. While no one suggested replacing traditional textbooks and related materials with graphic novels, the teachers did see the graphic novels as a "wonderful additional resource." They seemed to perceive graphic novels in content areas as a "faster and less dense" means for connecting with more students. Following is a list from the focus groups and evaluation forms of the potential benefits of using graphic novels to engage all students:

- Boys will enjoy the medium.
- Gifted and talented students would like them.
- They meet the needs of a wide range of readers.
- They are good for ESL.
- They integrate multiple ethnicities.
- The writing style is student-like and readers could easily relate.

Several scholars have already advocated graphic novels for opening up the curriculum, especially for secondary students. Krashen (2005) suggests the medium can help reluctant readers, especially children of poverty who have little access to books. Schwarz (2005) argues that graphic novels promote diversity, and Cary (2004) presents research and teaching ideas for using the graphic novel with ELL (English Language Learners) as well as foreign language learners. These educators also discussed the notion that graphic novels may help teachers reach more students.

Educator participants also acknowledged that graphic novels, a medium that combines print and image, could help accomplish other goals, such as promoting "higher order thinking" and offering "realistic connections and examples" and "some real world activities." They mentioned that this medium could promote content knowledge, "could introduce or reinforce concepts," and could "provide good visuals which support the content." Although participants are unsure of the impact and quality of graphic novels, particularly in elementary mathematics and science, the teachers are open to possibilities that several scholars have proposed. Khordoc (2001), for example, theorizes that although comics and graphic novels are often dismissed as a low art form, "it is important to point out that its various strategies are complex and sophisticated, and require skillful decoding by readers, and as such, should be studied and analyzed as they are in other

forms of literature and art" (159). One person mentioned that graphic novels are, in addition, already "big with Scholastic," the educational publisher so many educators trust.

Comments on the evaluation forms also revealed participants' positive views about the evaluated books and included such ideas as "it's great that they explain some of the higher level ideas or unknown vocabulary," "diagrams gave a good view of the digestive system," and "great that more info is provided at the back of the book."

On the other hand, participants also shared concerns and potential problems, many of which relate to the quality of the graphic novels used. Following is a list of characteristics teacher participants mentioned in the focus groups and in their specific graphic novel evaluations that speak to the overall questionable quality of the graphic novels examined:

- Contrived plot, unclear plot, mathematics/science content unrelated to the plot
- Dumb characters
- Heavy vocabulary
- Too babyish
- Some difficult readability
- Moves back and forth between past and present tense

Participants further indicated that graphic novels with subject-matter content that are created and published to catch the wave of graphic novel popularity still need to offer sensible stories and be accessible and developmentally appropriate.

In addition, participants expressed concerns over weak mathematics or science content in the graphic novels they evaluated. Comments included their concern about "weak content, not much content," stories that contained "fallacies/incorrect conceptions" (e.g., of how the digestive track works), "confusion between fact and fantasy," "too few examples," "not much active involvement of the reader," "doesn't encourage the reader to ask more about the content," and that finally, the graphic novels are "not sufficient in themselves" and "require extensions to develop content." Participants indicated that good science or mathematics content was not necessarily included in these graphic novels. Additionally, although weak stories and plot development were revealed as part of the problem, the participants indicated that graphic novels that aspire to support elementary mathematics and science also might need to include additional features: good glossaries (or at least ways to explain terms), possible lab experiments, an engaging source of resources for further study, discussion questions, possible projects, and more of the kinds of content that may be available in textbooks. The bottom line, as the participants articulated, is that the graphic novel that supports mathematics or science content must include a good, sensible story *and* must have useful, accessible, interesting, worthwhile science or mathematics content.

Finally, the educators expressed concern about possible negative reactions from parents, the need to teach students how to read graphic novels, and anxiety about whether graphic novels were actually good choices for struggling readers. The last may refer to the question of academic worth expressed earlier. Are graphic novels just a cop out, or can they really be both good literature and rich in content, serving the needs of all students?

Implications

Despite numerous references and research studies specific to literature integration in the content areas, there is a noticeable absence of studies that explore elementary educators' views toward graphic novels in general, toward the utilization of the genre in the elementary classroom, or toward graphic novels that are focused on mathematics and science content. Because this absence is occurring while the number of graphic novels targeting the younger child is increasing, the findings of this study are worthy of discussion as they have implications for future developments in the area of graphic novels in the elementary classroom.

The research questions focused on educators' personal perspectives toward graphic novels, the utilization of graphic novels in the elementary classroom, and how those perspectives are informed by a mathematics- or science-content focus. The two-stage research design employed in the study allowed for data to be gathered that was relevant to and informed both research questions during both stages. First, utilizing a review guide designed expressly for this study that incorporated specific mathematics, science, and graphic-novel literary elements, participants were provided the opportunity to reflect on and provide explicit feedback on six mathematics- and science-focused graphic novels. Immediately following the completion of their individual trade book review forms (while personal feelings and perspectives were fresh and focused), participants joined in a group focus session where personal perspectives toward

mathematics- and science-focused graphic novels and the utilization of graphic novels in the elementary classrooms could be explored and discussed. Qualitative results recorded through graphic novel review forms and focus group sessions indicated that the review guide informed both personal and professional perspectives and revealed a variance in participants' perspectives. What one participant reflected on positively, another participant could view negatively. When providing feedback of the text *A Journey into the Human Body*, one participant indicated that the science content was "easy to follow from start to finish" while another participant stated that the science content of the text was "hard to follow." Similarly, during the focus group session, one participant indicated, "I don't like fiction. I'm a nonfiction person and I felt like I had to dig for what I wanted to get out of it [the graphic novel] because there was too much fluff going on," while another participated stated, "Well, it's total opposite with me. I liked it more because I could get to that stuff in not just a nonfiction sort of way."

Moreover, results revealed that individual participants' understanding of what constituted a graphic novel and what constituted appropriate ways in which graphic novels could be incorporated in the elementary classroom varied. These findings are indicative of the fact that study participants are first and foremost individuals whose perspectives are shaped by their life experiences. As graphic novels are a relatively new genre (especially content-specific texts designed for the young child), participants presented variance in their prior experiences with the genre and, subsequently, these experiential variances were revealed through participants' personal and educational perspectives.

Based on these study results, in which participants offered both diverse and shared opinions, some recommendations might provide guidance for classroom teachers and librarians considering graphic novels for their classrooms and schools.

- Media literacy refers to competencies that enable individuals to create, analyze, and evaluate messages in a variety of forms and genres. Graphic novels are a relatively new genre, and as study participants presented variance in their recognition and understanding of this genre, there may be a need to prepare and offer media literacy professional development opportunities at both the in-service and preservice teacher levels.
- Parents need to be included in educationally relevant, classroom-focused discussions specific to media literacy and graphic novels. Just as educators expressed variance in their understanding of the genre, it stands to reason that parents also would express variance. Subsequently, parents need access to information specific to media literacy and graphic novels so they can actively and knowledgeably assist their children in choosing texts and support educators who use these texts.
- Librarians are responsible for providing materials that are appropriate for the individuals they serve. When those individuals are young children, this responsibility takes on added significance because of the detrimental effects of providing inappropriate materials. Additionally, teachers look to librarians for information and advice relative to the suitability of both print and nonprint materials for classroom use. Graphic novels represent a new medium for young children, and librarians have taken the lead in providing information and recommendations regarding the genre. Yet with the rapid influx of graphic novels aimed at the young child, and with many of these texts being content-specific, it is essential that librarians remain vigilant to the task of advocating and recommending appropriate graphic novels across the curriculum. Moreover, all might benefit if teachers and librarians together would discuss what makes for good graphic novels for students.
- When reviewing and utilizing curriculum materials that suggests graphic novels, it is important for educators to inquire about how text lists were formulated. A review guide or evaluation instrument should be located and a review process should be incorporated if educators cannot determine the origin of these lists. Educators need reliable recommendations on new materials.
- Harris (2008) indicated that graphic novel literature has recently experienced "a bit of a publishing storm" with an increase in sales of the works due, in part, to the fact that the genre is no longer viewed as "an underground art form" (426). Numerous publishers have jumped on the graphic novel bandwagon; as a result, graphic novels in general (and content-focused graphic novels specifically) are becoming more prevalent in the classroom. However, there is a great void in the area of research regarding the utilization and impact of the genre on teachers and children, and that void must be filled in addition to the study of what makes quality literature.
- "The graphic novel now offers just as many fine creative talents . . . as any literary genre ever has done" (Tabachnick 2007, 11). When the recognition of this talent is juxtaposed with the fact that graphic novels have experienced a "publishing storm," the need for publishers to seek and utilize all available talents to assure that the necessity and desire for quality graphic novel literature is not washed away by this storm is both exposed and highlighted. Additionally, regarding content-specific graphic novels, publishers must involve experts within the content areas to guarantee that quality designations extend to the integrity of the content.

Conclusion

New media have great potential in the classroom, and graphic novels, already popular outside of school, may support instruction in elementary science and mathematics as well as other areas. However, all materials published are not school worthy. A small study of local educators, using a specifically designed mathematics and science graphic novel review guide followed by focus group discussions, indicates that just because a graphic novel may seem useful in science or mathematics instruction, it may not be. Educators can, of course, evaluate these materials themselves, but it also might be helpful if librarians and professional organizations like NCTM or the National Council of Teachers of English (NCTE) used such instruments to evaluate and review graphic novels for teachers. Furthermore, as with all new content or methods, teachers need training to help them understand and use new media like graphic novels, and they need to be working with parents and administrators as they implement new curricula. Much future study is needed as teachers actually use graphic novels to support teaching across the curriculum.

Works Cited

Atkinson, T. S., M. N. Matusevich, and L. Huber. 2009. Trade book choices for elementary classrooms. *The Reading Teacher* 62: 484–97.

Boatright, M. D. 2010. Graphic journeys: Graphic novels' representations of immigrant experiences. *Journal of Adolescent & Adult Literacy* 53: 468–76.

Campbell, E. 2007. What is a graphic novel? *World Literature Today* 81(2): 13.

Carter, J. B. 2007. Transforming English with graphic novels: Moving toward our "Optimus Prime." *English Journal* 97(2): 49–53.

Cary, S. 2004. *Going graphic: Comics at work in the multicultural classroom.* Portsmouth, N.H.: Heinemann.

Chipman, I. 2010. Graphic novels with science and math themes. *Book Links* 106(19–20): 8–10.

Crutcher, P. A. 2011. Complexity in the comic and graphic novel medium: Inquiry through bestselling Batman stories. *Journal of Popular Culture* 44(1): 53–72.

Evans, C. W., A. J. Leija, and T. R. Falkner. 2001. *Math links: Teaching the NCTM Standards through children's literature.* Englewood, Colo.: Teachers Ideas.

Frey, N. and Fisher, D., eds. 2008. *Teaching visual literacy: Using comic books, graphic novels, anime, cartoons, and more to develop comprehension and thinking skills.* Thousand Oaks, Calif.: Corwin.

Gorman, M. 2008. Graphic novels rule! *School Library Journal* 54(3): 42–49.

Gutierrez, P. 2009. Good and plenty. *School Library Journal* 55(9): 34–39.

Hall, J. R. 2011. Books worth reading. *Change: The Magazine of Higher Learning* 43(2): 39–43.

Halsey, P., and S. Elliott. 2007. Assessing textbook publishers' recommendations for using children's literature in science. *ElectronicJournal of Literacy through Science* 6(1): 26–40.

Harris, V. J. 2008. Selecting books that children will want to read. *Reading Teacher* 61: 426–30.

Hellwig, S., E. E. Monroe, and J. S. Jacobs. 2000. Making informed choices: Selecting trade books for mathematics instruction. *Teaching Children Mathematics* 7: 138–43.

Hunsader, P. D. 2004. Mathematics trade books: Establishing their value and assessing their quality. *Reading Teacher* 57: 618–29.

Jung, T., H. Chung, and M. Spoor. 2005. *The math game I.* Australia: YoungJin Singapore.

Khordoc, C. 2001. The comic book soundtrack: Visual sound effects in *Asterix.* In R. Varnum and C. T. Gibbons, eds., *The language of comics: Word and image*, 156–73. Jackson: Univ. Pr. of Mississippi.

Krashen, S. 2005. The "decline" of reading in America, poverty and access to books, and the use of comics in encouraging reading. **www.sdkrashen.com/articles/decline_of_reading/01.html** (accessed Nov. 22, 2010).

Law, F., and S. Way. 2010. *The mystery of nine: Number place and value in action.* New York: Windmill.

Letize, A. R. 1997. Connecting process problem solving to children's literature. *Teaching Children Mathematics* 3: 398–406.

Mayer, D. A. 1995. How can we best use children's literature in teaching science concepts? *Science and Children* 32(6): 16–19.

Miles, M. B. and A. M. Huberman. 1994. *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks: Sage.

Morrison, J. A., and T. A. Young. 2008. Using science trade books to support inquiry in the elementary classroom. *Childhood Education* 84(4): 204–8.

Murphy, S. J. 2000. Children's books about math: Trade books that teach. *New Advocate* 13: 365–74.

Nesmith, S. and S. Cooper. 2010. Trade books in the mathematics classroom: The impact of many, varied perspectives on determination of quality. *Journal of Research in Childhood Education* 24(4): 1–19.

O'Donnell, L., et al. 2007. *The shocking world of electricity with Max Axiom, super scientist*. Bloomington, Minn.: Capstone.

O'Callaghan, C. M., P. A. Antonacci, L. P. Murphy, F. D. Musiello, and E. Wolfson. 2011. *Using children's literature across the curriculum: A handbook of instructional strategies*. Boston: Pearson/Allyn & Bacon.

Oh, S. 2005. *A journey into the human body*. Australia: YoungJin Singapore.

Owens, C. V. 2003. Nonsense, sense and science: Misconceptions and illustrated trade books. *Journal of Children's Literature* 29(1): 55–62.

Rice, D. D. 2002. Using trade books in teaching elementary science: Facts and fallacies. *The Reading Teacher* 55: 552–65.

Schiro, M. 1997. *Integrating children's literature and mathematics in the classroom: Children as meaning makers, problem solvers, and literary critics*. New York: Teachers College.

Schwarz, G. 2005. Embracing diversity through graphic novels. *Telemedium* 52(1 & 2): 64–66.

———. 2009. From popular culture to pabulum? *AEQ (Academic Exchange Quarterly)* 13(2): 8–14.

Short, J. C. and T. C. Reeves. 2009. The graphic novel: A "cool" format for communicating to Generation Y. *Business Communication Quarterly* 72: 414–30.

Thielbar, M., and Y. Ota. 2010. *Manga math mysteries 3. The secret ghost: A mystery with distance and measurement.* Minneapolis, Minn.: Graphic Universe.

Tabachnik, S. E. 2007. A comic-book world. *World Literature Today* 81(2): 24–28.

Tabachnik, S. E., ed. 2009. *Teaching the graphic novel*. New York: Modern Language Association.

Teale, W. H., J. Kim, and W. Boerman-Cornell. 2008. It's elementary! Graphic novels for the K–6 classroom. *Book Links* 17(5): 6–7.

Whitin, D. and P. Whitin. 2001. What counts in math-related books for children. *Journal of Children's Literature* 27(1): 49–55.

Yellin, D., M. E. Blake, and B. A. DeVries. 2000. *Integrating the language arts*. Scottsdale, Ariz.: Holcomb Hathaway.

Ykids. 2007. *Einstein*. YoungJin Singapore.

Appendix A. Mathematics and Science Graphic Novel Review Form [PDF]

*form adapted from that created by Patricia D. Hunsader (2004)

Appendix B. Focus Group Protocol

- Have you ever read a graphic novel before? What was it and what did you think about it?
- What do you think a graphic novel is?
- Graphic novels are increasingly popular among educators. Why do you think? What would be the advantages of using graphic novels in school?
- Based on your study of the graphic novels we supplied—which are math- and/or science-related—do you think you would use a graphic novel in **your** classroom? Why/why not?
- Would you like to learn more about graphic novels? Explain.
- Do you see any potential problems with using graphic novels in the classroom?
- Anything else we should ask about that we have not yet asked?

Reviewer: _____ Date: _____

Book name: Author: Publisher and date:	
Mathematics/Science content of book:	Target audience (circle all appropriate): preschool K 1 2 3 4 5 6 7 8 9

Mathematics Standards

Is the book's mathematics content (text, computation, scale, vocabulary, and graphics) correct and accurate?	5 4 3 2 1 NA correct partially incorrect
Comments:	

Is the mathematics content visible and effectively presented?	5 4 3 2 1 optimally partially poorly
Comments:	

Is the book's mathematics content intellectually and developmentally appropriate for its audience?	5 4 3 2 1 optimally partially unsuited
Comments:	

Does the book facilitate the reader's involvement in, understanding of, and use/transfer of its mathematics?	5 4 3 2 1 optimally no effect inhibit
Comments:	

Do the book's mathematics and story complement each other?	5 4 3 2 1 optimally no effect detract
Comments:	

How great are the resources needed to help readers benefit from the book's mathematics?	5 4 3 2 1 minimal average excessive
Comments:	

Science Standards

Is the book's science content (text, scale, vocabulary, passage of time, and graphics) accurate and current?	5 4 3 2 1 NA accurate partially inaccurate
Comments:	

Is the science content visible and effectively presented?	5 4 3 2 1 optimally partially poorly
Comments:	

Is the book's science content intellectually and developmentally appropriate for its intended audience?	5 4 3 2 1 optimally partially unsuited
Comments:	

Does the book facilitate the reader's involvement in, understanding of, and use/transfer of its science content?	5 4 3 2 1 optimally no effect inhibit
Comments:	

Are the text's theories and facts easily distinguished and/or are theories and facts discernable from fiction or fantasy?	5 4 3 2 1 optimally partially minimally
Comments:	

To what degree does the text promote a positive attitude toward science and technology?	5 4 3 2 1 optimally partially minimally
Comments:	

Literary Standards for Graphic Novels

Does the plot exhibit good development, imagination, and continuity? Are the characters (if any) believable and well developed?	5 4 3 2 1 excellent poor
Comments:	

Does the book contain a vivid and interesting writing style that actively involves the child?	5 4 3 2 1 excellent poor
Comments:	

Are the book's illustrations and graphics text-relevant, appealing, and representative of a child's perspective?	5 4 3 2 1 excellent poor
Comments:	

Are the book's readability and interest level developmentally appropriate for the intended audience?	5 4 3 2 1 excellent poor
Comments:	

Do the book's plot, style, and graphics/illustrations complement one another?	5 4 3 2 1 excellent poor
Comments:	

Does the book respect the reader by presenting positive race, gender, ethical, and/or cultural values?	5 4 3 2 1 excellent poor
Comments:	

*form adapted from that created by Patricia D. Hunsader (2004)