



## Attitudes regarding Perceived Values and Usefulness of Mathematics in a Community College Mathematical Literacy Course

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### ABSTRACT

As the nation seeks for new and efficient ways to address the high failing rate in developmental mathematics, many community colleges have begun experimenting with alternative design for remedial mathematics sequences. One approach was to implement mathematical literacy in their program, focusing on quantitative reasoning. The mathematics literacy course involved in this study is MAT 41, “an innovative remedial mathematics course designed to prepare and move students to college-level work more quickly” (Carnegie Foundation, n.d.). The drive of this study was to observe and evaluate learner attitudes regarding perceived values and usefulness mathematics in a community college mathematical literacy course using a mixed method approach. Two groups of students who were in need of basic skills in mathematics at the level of remediation were surveyed, one group taking mathematical literacy courses and another group taking algebra courses. To measure students’ growth in the perceived value and usefulness of mathematics, quantitative data were collected with a pre- and post-mathematics attitudes survey from the mathematical literacy course and the elementary algebra course. In addition, qualitative data were gathered with an open-ended question administered to participants in the mathematical literacy sections during the last week of the semester. Findings from the quantitative data revealed statistically significant effects for participants in the mathematical literacy course compared to their counterparts in the elementary algebra course in attitudes regarding the perceived value and usefulness of mathematics. Qualitative data were aligned with the findings from the quantitative data and indicated participants’ positive views on the usefulness of the mathematical literacy course, and improvement of their attitudes regarding mathematics.

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### 1. Introduction

In recent years, the rate of failure amongst students in developmental mathematics is very high (Bailey, Jeong, & Cho, 2010; George, 2010; Bonham et al., 2011; Howell, 2011). Only 38% of students across community colleges at the City University of New York (Office of Institutional Research and Assessment, 2015), or 44% of developmental mathematics students (Mejia, Rodriguez, & Johnson, 2016) complete the developmental mathematics programs, and the probability of such learners finishing their degree programs is very low (Bailey, 2009). According to Mejia et al. (2016), only 27% of learners who enroll in a developmental mathematics course eventually complete a college mathematics course with a grade of “C” or better. This high failure rate in remedial mathematics education costs \$435 to \$543 million per year to colleges and universities (Howell, 2011).

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To help learners experience success when taking traditional remedial mathematics, many community colleges' developmental mathematics programs are facing reforms and redesigns to improve their curriculum and instruction. An example of the new approaches is to implement a mathematical literacy program focusing on quantitative reasoning. The mathematics literacy course involved in this study is "an innovative remedial mathematics course designed to prepare and move students to college-level work more quickly" (Carnegie Foundation, n.d.). (The course has been developed in collaboration with the Carnegie Foundation.) The course is a non-credit developmental course taught for 4 hours a week using a "student-based pedagogy that encourages learners to struggle with real-world problems that need mathematics rather than memorizing procedures for solving algebraic equations" (Carnegie Foundation, n.d.).

Mathematical literacy can play a role in improving learners' achievement. Fewer students would fail (Stith, 2001) in a mathematics classroom using a mathematical literacy approach with relevant and functional contexts (Steen, 2001c) that students are interested in (Allen, 2001; Malcom, 1997). Many studies illustrate this. For instance, Schiefele and Csikszentmihalyi (1995) revealed a positive correlation between interest and achievement. Koller, Baumert, & Schnabel (2001) revealed a relationship between interest and achievement at the secondary level.

Mathematical literacy also can promote student motivation, defined as "the reason individuals have for behaving in a given manner in a given situation" (Middleton & Spanias, 1999, p. 66). If students regularly engage with mathematics that is relevant, interesting, and accessible, then they may start to develop intrinsic motivation for the subject. Teaching for mathematical literacy may be the "radical and consistent change" (p. 75) that is required to overcome the lack of motivation in students, as it focuses on skills that learners need so as to understand the quantitative situations in their day-to-day lives.

Jordan and Haines (2003) described the growth of mathematical literacy at Lawrence University, where students developed a higher level of appreciation for the utility of statistics.

Using a quantitative design, Van Peurse, Keller, Pietrzak, Wagner, and Bennett (2012) attempted to compare a college algebra course and a mathematical literacy course by means of an examination modeled after the Collegiate Assessment of Academic Proficiency (CAAP) examination. They found that students in mathematical literacy reported higher gains in attitudes toward mathematics and felt that mathematics had more value and utility for their lives. Mathematical literacy students felt that they could better apply knowledge, and they scored higher on the application problems.

### 1.1. Purpose and Research Question

The intent of conducting this study was to observe and evaluate learner attitudes regarding perceived value and usefulness of mathematics. Researching the topic of mathematical literacy is of importance to administrators, instructors, and researchers because of the low completion rates in college-level mathematics and remedial mathematics education. This study will provide additional evidence to the literature that teaching mathematical literacy improves students' attitudes regarding perceived value and usefulness of mathematics. In addition, this study advances the literature because the mathematics education system will earn insight into ways that might enhance the teaching outcomes and learning outcomes. This study will fill a gap by being one of a few that utilizes a mixed-methods approach that provides a more in-depth understanding of the effects of mathematical literacy on students' attitudes regarding perceived value and usefulness of mathematics. The following research question guided me in the study's analysis: "How are attitude toward the value and usefulness of mathematics, affected by taking a mathematical literacy course? What are the views of students concerning their experiences in a community college mathematical literacy course?"

### 1.2. Significance of the Study

Researching the topic of mathematical literacy is of importance to administrators, instructors, and researchers because of the low completion rates in college-level mathematics and remedial

mathematics education. This study of mathematical literacy is important, as it may inform community college developmental mathematics programs and instructors about the value of incorporating mathematical literacy courses into instructional practices for addressing the non-completion problem in college mathematics. This study will provide additional evidence to the literature that teaching mathematical literacy improves students' attitudes.

In addition, this study advances the literature because the in-depth open-ended questions will clarify students' point of views regarding mathematics, provide deeper insight into students' responses to the pedagogy of the mathematical literacy course and will propose ways that instructors in colleges can improve learners' performance and attitudes regarding mathematics. This study will fill a gap by being one of a few that utilizes a mixed-methods approach that provides a more in-depth understanding of the effects of mathematical literacy on students' attitudes regarding mathematics.

## **2. Methodology**

### **2.1. Overview of the Mathematical Literacy Course**

The mathematics literacy course involved in this study is MAT 41, "an innovative remedial mathematics course designed to prepare and move students to college-level work more quickly" (Carnegie Foundation, n.d.). (The course has been developed in collaboration with the Carnegie Foundation.) MAT 41 is a non-credit developmental course taught for 4 hours a week using a "student-based pedagogy that encourages learners to struggle with real-world problems that need mathematics rather than memorizing procedures for solving algebraic equations" (Carnegie Foundation, n.d.). To make sense of the world, the mathematical literacy course focused on applications of quantitative reasoning, involving topics from arithmetic, proportion, and basic algebra using three themes (Appendix C):

- Citizenship: students study how to understand quantitative information about societies, government, and the world that is important in many decisions they make.
- Health: students learn how to understand quantitative information about health issues and medical treatments.
- Personal finance: students learn how to understand and use quantitative information to make decisions in their lives.

### **2.2. Setting and Participants**

The research was conducted in an accredited two-year public college in the greater New York City area. Learners entering the school are assessed through placement examinations and reviews of their performance records from high schools to determine their competence in basic skills. The results from such exams are used to place students in the developmental mathematics courses they need to master before taking credit-bearing mathematics coursework.

To evaluate the effects of a mathematical literacy course on students' attitudes towards perceived value and usefulness of mathematics, two groups of students were surveyed, one group taking mathematical literacy courses and another group taking algebra courses. Students are placed into developmental mathematics and/or college-level mathematics courses based on Assessment Test Scores.

Based on their intended major, students who take the ACT's COMPASS placement exam and have a score lower than 40 on the elementary algebra part and a score greater than 45 on the arithmetic part are placed in the elementary algebra courses (MAT 51). If students' fields do not require calculus, then students are placed in the mathematical literacy QuantWay courses (MAT 41). 28 students from two sections of a mathematical literacy course and 40 students from three sections of an elementary algebra course were part of the study. Participants were informed of the objective of the study and their roles and were not forced to participate in the study and could stop at any moment.

### 2.3. Instrument

A mixed-methods study was selected to address the research questions of this study. A convergent mixed approach design was utilized, which is “a kind of design in which both quantitative and qualitative data are collected simultaneously, analyzed separately and then merged” (Creswell, 2018, p. 18).

Tapia’s Attitudes Towards Mathematics Inventory (Tapia, 1996) was used to collect and analyze quantitative pre- and post-survey data about learners’ attitudes regarding mathematics. Items from such frameworks that measure attitudinal variables of value and usefulness of mathematics (beliefs of students about usefulness and relevance of math in their lives) were selected. Additionally, these frameworks guided the analysis of the qualitative data gathered through open-ended questionnaires, particularly how learners’ views concerning their experiences support or challenge the quantitative findings.

During the first and last week of the 2017 fall semester, a survey of 5 questions (Appendix A) was administered to students in the mathematical literacy and elementary algebra courses. One of the purposes of the survey was to gain some insight into the changes of student attitudes regarding perceived value and usefulness of mathematics. In addition, an open-ended survey of two questions (shown in Appendix B) was given to students after completing the mathematical literacy course.

### 2.4. Data Collection and Analysis

To answer the research question, the pre- and post-surveys were given to students to examine if any correlation existed between the mathematical literacy courses and student growth in perceived value and usefulness of mathematics. The value and usefulness of mathematics included five items each. They were measured using a Likert Scale Questionnaire 1-5, coded as: “Strongly agree = 5, Agree = 4, Neutral = 3, Disagree = 2 and Strongly disagree = 1.” Item 5 was reverse coded. A composite score was calculated as the total of the five items and could range from 5 to 25, with larger scores meaning a more positive attitude.

All subsequent analysis about the mathematics attitudes surveys were conducted using a descriptive statistic, SSPS, and independent t-tests (Creswell, 2018), which is more appropriate to compare two groups in terms of outcomes (Creswell, 2018, p. 159).

The qualitative data were analyzed following the steps advised by Creswell (2018): “Organize and prepare the data for analysis; read or look at all the data and start coding all the data. Coding is the process of organizing the data” (p. 193). After collecting and organizing data, responses were coded as yes, no, or blank for students’ attitudes toward the mathematical literacy course, and were coded as indicative of a positive change, a negative change, or no real change for students’ attitudes toward mathematics. These questions provided students with opportunities to share what they liked or disliked about the course and offer richer insights into the results of the aforementioned surveys.

### 2.5. Validity and Reliability

By following the recommendations of Creswell (2018), multiple validity procedures were utilized to “enhance the ability to assess the accuracy of findings as well as convince reader of that accuracy” (p. 200). Creswell indicated eight primary strategies to check for validity: “Triangulate different data sources, use member checking, use a rich, thick description, clarify the bias the researcher brings, present negative or discrepant information, spend prolonged time in the field, use peer debriefing, and use an external auditor” (pp. 200-201). In this study, expert panels, spending time in the field, and triangulation were used to ensure validity of the findings. The issues of validity were addressed by having a team of critical colleagues review the research instruments and the data, either collaboratively or independently. Based on their comments and feedback, questions that were unclear or obscure were revised and reworded. Also, by teaching many sections of mathematical literacy and elementary algebra within the same site of the study, the researcher “develops an in-depth

understanding of the phenomenon under study” (p. 201). Finally, to strength the validity of the data analysis and findings, quantitative data were gathered through Likert-type questions, and qualitative data were collected through open-ended questions. Opinions that learners have about the mathematics attitude surveys were cross validated with their responses from the open-ended questions.

Creswell (2018) declared that reliability of data and findings indicate that the “researcher’s approach is consistent across different researchers and different projects” (p. 199). Further, Nunan (1999) stated that reliability addresses the dependability and replicability, as well as the consistency of the “results obtained from a piece of research” (p. 14). To strengthen the reliability of this study, the different steps of the procedures were clearly explained. Additionally, various procedures such as open-ended questions and Likert-type questions were used to collect data, and information was obtained from different learners in five courses’ sections. Consequently, this strategy adds reliability to the data and the findings in this study.

### 3. Results

The research question evaluated any change in participants’ growth in perceived value and usefulness of mathematics after completing the mathematical literacy course and elementary algebra.

#### 3.1. Student Attitudes Toward the Value and Usefulness of Mathematics

How are attitude toward the value and usefulness of mathematics, affected by taking a mathematical literacy course? The score could range from 5 to 25, with a larger score reflecting a greater positive attitude regarding the perceived value and usefulness of mathematics. Overall, participants reported positive changes in the value and usefulness of mathematics. The reported mean score value and usefulness for the elementary algebra courses increased from 16.28 to 17.35 and from 17.46 to 19.79 for the mathematical literacy courses. Students in the mathematical literacy reported a gain of 2.33 points, while students in elementary algebra reported a gain of 1.08. Results of this analysis revealed a difference between the post-test scores of the two groups that was statistically significant ( $t = 2.712, p = 0.0085$ ). The mathematical literacy group seems to have increased in attitude regarding the perceived value and usefulness of mathematics (Table 1).

**Table 1.** Table 1. Pre- vs. Post-survey Value and Usefulness of Mathematics Using t-Test

Group	N	Pre		Post		95%		t-test	P-value
		$\bar{X}$	SD	$\bar{X}$	SD	lower	upper		
MAT41	28	17.46	3.45	19.79	3.95	.34	4.32	2.31	.0222**
MAT51	40	16.28	3.86	17.25	5.58	-.94	3.09	1.08	.28 <sup>NS</sup>

Scores could range from 5 to 25. Note: \*\*=  $p < 0.05$ ; <sup>NS</sup> = Not Significant

#### 3.2. Views of Students Concerning their Experiences

What are the views of students concerning their experiences in a community college mathematical literacy course? The second research question was included to allow students the opportunity to elaborate on their overall experiences in the course. An open-ended questionnaire (Appendix B) was distributed during the last week of the semester in the mathematical literacy courses.

#### 3.3. Students’ Attitudes About the Mathematical Literacy Course

Participants were asked about the usefulness of this specific course compared to the previous courses. Their responses were coded as yes, no, or blank. With the exception of two students who indicated no and four students who left this question blank, all other students’ responses revealed that yes, the mathematical literacy course was more useful compared to their previous mathematics courses.

Many of the students’ comments reflected ideas and themes such as valuing of the usefulness of the material. Johanna stated, “I found it useful, because I have taken a mathematics course before; I have

not learnt nothing from my old mathematics class, but [in] this class I learnt a lot." Raymond similarly pronounced, "I found this course [more] rewarding than the previous mathematics course, because of the amount of helps and after class help I received." Juan likewise affirmed, "I found this course useful. We used everyday real-world situations. We used mathematics equations to solve problems such as budgets, insurance eligibility, things we encounter in real life." Kadajah concurred, saying, "More useful. I feel like I may use this in real-life." Mariama stated, "Yes, because our class had a personal tutor that was available to us all week. He was very thorough and helpful." Jose stated, "I found this course useful in comparison to my last course because I was able to understand the work much better." Similarly, David stated, "I found this course pretty useful because I learnt a lot more than before." Richard said, "Yes, I find it useful because it improved my mathematics skills." Lala stated, "Yes, because this course offered a more practical form of mathematics useful in everyday life. Patricia declared, "It was very useful, because I had a good professor." Gabriela stated, "It was more useful, because the professor took time out to explain stuff I did not know."

### 3.4. Students' Attitudes Toward Mathematics

Participants were asked whether the course led to changes in any of their attitudes or opinions regarding mathematics. Responses were coded as indicative of a *positive change*, a *negative change*, or *no real change*. With the exception of three students who indicated a *negative response* and four students who left the questions blank, students generally indicated a *positive change*. Lishaune stated, "Not particularly." Marie wrote, "Not really." Similarly, Jessica stated, "No."

Generally, the students' comments were overwhelmingly positive about their own perceived attitudinal changes toward mathematics. Some indicated feeling more mathematically confident. For example, Awa, revealed seeing the usefulness of the subject: "Yes, it makes me know more about the importance of mathematics." Likewise, Kim wrote, "Yes, I can apply it in my life." Brianna stated, "Yes, it made me more aware of what is going on with real-life situations." Specific comments were made by other students. For example, Mariama pronounced, "Yes, it made me understand mathematics more and see different ways to do a mathematics problem. Juan stated, "Yes, I feel mathematics is a little more entertaining, and I like the feeling I get when I solve a problem." Daniella wrote, "Yes, I have a better understanding in what I am doing." Lala pronounced, "This class has been different, and enjoyable. We have learnt real-life skills, which is something most of my previous mathematics classes do not offer."

## 4. Discussions and Conclusion

Statistically significant effects were discovered regarding perceived value and usefulness of mathematics for participants in the mathematical literacy sections compared to their counterparts in the elementary algebra sections. The qualitative data indicated participants' positive views of the usefulness of the mathematical literacy course and feeling that the course helped improve their attitudes regarding mathematics.

### 4.1. Student attitudes toward the value and usefulness of mathematics

Findings based on both the qualitative and the quantitative data revealed that students enrolled in the mathematical literacy sections perceived increased value and usefulness of mathematics.

The quantitative data indicated that the mean scores for perceived value and usefulness of mathematics increased for both courses, but students in the mathematical literacy sections had a greater mean increase than students in the elementary algebra sections. Results of this analysis revealed a difference between the post-test scores of the two groups that was statistically significant. The mathematical literacy group seems to have increased in attitude regarding the perceived value and usefulness of mathematics.

The qualitative data were aligned with the quantitative findings. Students were asked whether the mathematical literacy course made changes in any of their attitudes or opinions regarding

mathematics, and the usefulness of this specific course in comparison to their previous courses. Their comments were positive and indicated a growth perceived value and importance of studying mathematics. Students compared their actual mathematical literacy course's experiences with their previous mathematics courses. For example, Awa stated, "Yes, this course makes [me] know more about the importance of mathematics." Kim wrote, "Yes, I can apply mathematics in my life." Similarly, Bryanna declared, "Yes, this course made me understand mathematics more and see different ways to do a mathematics problem."

#### 4.2. Students' attitudes about the mathematical literacy course

Participants were asked about the usefulness of this specific course compared to previous courses. Almost all responses suggested that the mathematical literacy course was more useful and rewarding than previous courses; however, the most common theme was students' valuing the usefulness of the material, sometimes even highlighting a difference between the practicality of this material and the lack thereof in prior mathematics courses. Johanna stated, "I found it useful, because I took mathematics course before, I did not learn nothing from my old mathematics class, but this class I learnt a lot." Similarly, Raymond pronounced, "I found this course more rewarding than the previous mathematics course, because of the amount of supports and after class help I received." Jose stated, "I found this course useful in comparison to my last course because I was able to understand the material much better." Juan likewise affirmed, "I found this course useful. We used everyday real-world situations. We used mathematics equations to solve problems such as budgets, insurance eligibility, things we encounter in real life." Kadijah concurred, saying, "More useful. I feel like I may use this in real life."

#### 4.3. Findings and Existing Research Studies

This study contributed to the mathematical literacy literature by being one of just a few to use a mixed-methods approach to examine a mathematical literacy course. The findings of this study are in line with the results of Jordan and Haines (2003), who described the growth of mathematical literacy at Lawrence University where students were found to have a higher level of appreciation for the utility of mathematics. Findings in this study revealed that students enrolled in the mathematical literacy sections perceived an increased value and usefulness of mathematics. Also, the results of this dissertation support the findings of Dingman and Madison (2010), who found a positive change in student reports about the usefulness of mathematics as a result of taking a mathematical literacy course.

The findings of this dissertation study support the finding of Van Peursem et al. (2012), who found that students in mathematical literacy reported high gains in attitudes toward mathematics and felt that mathematics had more value and utility for their lives.

#### 4.4. Implications for Teachers and Researchers

The drive of this study was to observe and evaluate the effects of a mathematical literacy course on students' attitudes regarding mathematics. The quantitative and qualitative data revealed significant effects in the areas of attitudes regarding perceived value and usefulness of mathematics. This study adds evidence to the literature that teaching mathematical literacy improves students' attitudes.

The findings suggest an instructional practice that emphasizes teaching strategies such as staying away from traditional teaching methods by helping guide students in constructing their own knowledge of concepts through solving real-world problems relevant to their lives.

An additional recommendation is to emphasize the practicality of content whenever possible. Instructors should regularly engage learners with mathematics that is relevant, interesting, and accessible, using real data from various fields of study to help students develop quantitative reasoning skills. Mathematics instructors must be aware that if students learn any concept irrelevant to their lives, they will sooner or later dismiss it. In order to keep a mathematical concept alive and useable,

instructors must link topics to real life by using authentic problems. This encourages students to be active and engaged in their learning. Providing students with the necessary tools they need would increase and reinforce their interest and engagement.

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**Appendix A**

Pre- and Post-Mathematics Attitude Survey

STUDENT INFORMATION: These surveys will remain completely confidential. The student information asked below will only be used to help organize the information for data analysis.

Date: \_\_\_\_\_ Course: \_\_\_\_\_

\_\_\_\_\_

This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the response that most closely corresponds to how the statements best describes your feelings.

I study mathematics because I know how useful it is.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Knowing mathematics will help me earn a living.	Strongly disagreed	Disagree	Neutral	Agree	Strongly agree
Mathematics is a worthwhile, necessary subject.	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I'll need a good understanding of mathematics for my future work.	Strongly disagreed	Disagree	Neutral	Agree	Strongly agree
Doing well in math is not important for my future.	Strongly disagreed	Disagree	Neutral	Agree	Strongly agree

**Appendix B**

Open-Ended Survey Questions

(Administered at the end of the Mathematical Literacy course)

STUDENT INFORMATION: These surveys will remain completely confidential. The student information asked below will only be used to help organize the information for data analysis.

Date: \_\_\_\_\_ MAT041 \_\_\_\_\_

\_\_\_\_\_

- I. Did you generally find this mathematical literacy course more or less useful than previous mathematics courses? Why or why not?
  
- II. Do you feel this mathematical literacy course has changed any of your attitudes or opinions about the subject of mathematics? If so, in what ways?

## Appendix C

### Mathematical Literacy Outline of Topics

Weeks	Topics Covered	Lesson #
1	Week Introduction to Quantitative Reasoning What is Percent?	1.1 1.2
2	Week Affordable Care Act Whose Footprint is Bigger?	1.3 1.4
3	Week Interpreting Statements About Percentages Module 1 Review	1.5
4	Week Module 1 Assessment How Crowded Are We?	<b>Exam 1</b> 2.1
5	Week Counting Our Votes Measuring Population Change	2.2 2.3
6	Week Picturing Data with Graphics What is Average?	2.4 2.5
7	Week What is the Chances? Module 2 Review	2.6
8	Week Module 2 Assessment What is the Correct Dose?	<b>Exam 2</b> 3.1
9	Week The Facts on the Ground The Fixer Upper	3.2 3.3
10	Week Balancing Blood Alcohol A Return to Proportional Reasoning	3.4 3.5
11	Week Module 3 Review Module 3 Assessment	<b>Exam 3</b>
12	Week Modeling Money More Liner Modeling	4.1 4.2
13	Week Compounding Interest Makes Cents Compounding Makes More Cents	4.3 4.4
14	Week The Rising Seas Module 4 Review	4.5
15	Week Module 4 Assessment Final Assessment Review	<b>Exam 4</b>
15	Week Final Exam	<b>Final</b>

Source: Retrieved from the College's Mathematics Department Web