

**FROM GRAM STAINS TO GRAPHIC NOVELS: RESEARCHING A NEW WAY TO
TEACH MICROBIOLOGY**

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Table of Contents

Abstract.....	3
Introduction.....	4
Materials and Methods.....	8
Creating the Graphic Novel and Power Point Presentation.....	8
Study Population.....	13
Questionnaire Design.....	14
Consent and Recruitment.....	16
Lesson Delivery	17
Data Analysis.....	19
Ethics Application and Approval.....	20
Results.....	20
Graphic Novel.....	20
Direct Instruction (Power Point).....	22
Comparative Analysis.....	23
Discussion	24
Graphic Novel.....	24
Direct Instruction	25
Comparative Analysis.....	25
Qualitative Answers.....	26
Researcher Observations.....	27
Conclusion	29
Future Research/Directions.....	30
Funding	32
Acknowledgements.....	32
References.....	33
Appendix A: Microbe Mysteries Graphic Novel.....	36
Appendix B: Questionnaires	36
Appendix C: Consent and Recruitment Materials	43
Appendix D: Ethics Application and Approval.....	52

Abstract

The purpose of this study was to explore whether graphic novels could enhance microbiology literacy and engagement among school-aged children. Many students hold misconceptions about microorganisms, often perceiving them only as harmful due to limited coverage in the BC curriculum and their portrayal in the media. This project investigated whether introducing microbiology through storytelling and visuals increased engagement and fostered a more accurate and holistic understanding of microbes and their essential roles in health and the environment.

Grade 9 classrooms in the Central Okanagan School District, SD#23, participated in this pilot study. Classes were randomly selected to receive either a direct instruction presentation-based lesson (control), or to engage with a microbiology-themed graphic novel (intervention). Pre-instruction and post-instruction questionnaires assessed changes in knowledge, curiosity, and attitudes toward microorganisms through quantitative Likert-scale data and coded qualitative responses.

Results were analyzed using descriptive statistics on the quantitative data and general categorization of the qualitative data. The graphic novel had more statistically significant data, supported by student short answers, when evaluating its efficacy at dispelling microbiology misconceptions, supporting the notion that graphic novels and the visuals within them are beneficial to microbiology literacy. The direct instruction group had no statistically significant data before and after the lesson. In future studies, a greater sample size of students who receive each instructional method would be beneficial in representing any changes that occur from each learning tool.

Introduction

Misconceptions about microbiology can lead to a poor understanding of how vital microorganisms are to life on Earth and the vast roles they hold in all ecosystems. Attitudes towards science directly correlate to subjective understanding, so the more you understand a scientific concept the better your attitude will be towards it (Fonseca, et al., 2023). The pandemic caused by coronavirus SARS-CoV-2 also helped foster these misconceptions and contributed to a fear of microbes. In a sample of 405 participants aged 14 and older, researchers found commonly held misconceptions about microbes were equating bacteria, viruses, and microorganisms, believing that most microbes are harmful or associated with dirt and disease, and showing limited awareness of beneficial microbes or microbial diversity (Špernjak, Puhmeister, & Šorgo, 2023). This is consistent with findings from Giordan (2015) that states 92% of children and 76% of adults think microbes are bad and only lead to illness and death, and that all microbial activity is harmful to humans. Referring to microbes as “invisible enemies” in the media and from authoritative institutions reinforces the notion that microorganisms are harmful entities (D'Abramo & Neumeyer, 2020).

Many children see microorganisms as harmful and unhygienic, with misinformation most often stemming from certain media portrayals and, at times, from teachers (Hediye Deniz Karadon, 2010). For example, the media often uses scary language to highlight disease outbreaks but does not report on the groundbreaking medical microbiology technology that helps mitigate these diseases, leading to a general fear of microbes with no knowledge of their benefit (Byrne, 2011). The collective experience of the SARS-CoV-2 pandemic led to widespread exposure to the world of microbiology; however, this was often associated with negative things such as death, sickness, and disruptions to society. Simard (2023) proposes that this post-pandemic

period could be a significant opportunity to correct student's attitudes towards microorganisms since they have an unusual amount of prior exposure to them.

Microorganisms are the life-support system for all living things on Earth, and children should be knowledgeable of their crucial role in the global ecosystem (Cavicchioli, Ripple, & Timmis, 2019); (Byrne, 2011). Only 1% or less of microorganisms on Earth cause illness, a disproportionate number compared to society's fearful reactions of them (Nature Reviews Microbiology, 2011). The beneficial relationships and intricate connections between microorganisms, the environment, and all other life forms are absent from the British Columbia curriculum until Grade 8 (The Government of British Columbia, 2025). In a study performed in with 199 elementary school students, results showed that microbiology misconceptions improved in grade 6 and grade 2 students when additional teaching tools and specific, direct instruction were introduced beyond the curriculum (Ruiz- Gallardo & Paños, 2018). Gallardo & Paños (2018) evaluated the effectiveness of a presentation versus a hands-on activity and found no significant difference between the two teaching methods. Community-based STEM learning can successfully increase early microbiology literacy and reshape children's perspectives of microorganisms. Fatton et al. (2021) demonstrated that children both enjoy and retain more information about microbes when taught through creative methods including drawings and games.

While Constructivist Learning Theory emphasizes the importance of challenging previous experiences to evaluate what we know about new experiences to gain knowledge, much like the hands-on activity conducted in Gallardo & Paños' study, perhaps there is a more effective use of this pedagogy to correct microbiology misconceptions in youth. Storytelling supports this act of understanding through reflection and interaction, allowing individuals to

make meaning of abstract concepts and collaboratively build deeper, shared understanding (Lawrence & Paige, 2016). One First Peoples Principles of Learning is “learning is embedded in memory, history, and story”, which emphasizes the importance of storytelling in education and extends to include visual and performative storytelling (First Nations Education Steering Committee, 2025). Therefore, teaching microbiology content to students through storytelling would follow Piaget’s Constructivist Theory while honouring Indigenous pedagogy. The Universal Design for Learning (UDL) encourages the importance of developing learning resources and curriculum that are accessible, inclusive, and flexible for the broadest range of learners (Bernacchio & Mullen, 2007). This can be through making something relevant to students with multiple means of engagement and expression. Storytelling can be further adapted to the UDL framework when presented through multiple formats, such as written and oral narratives, visuals, and content relevant to learners’ experiences, making approaches like comic books or graphic novels particularly effective.

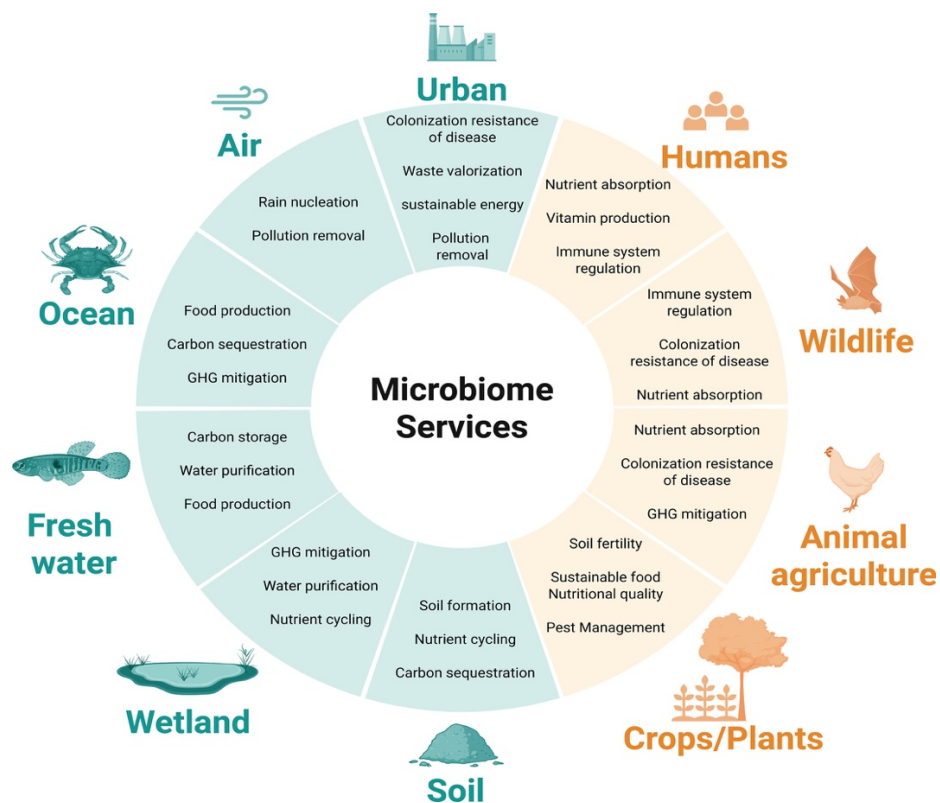
Graphic novels are continuously growing in popularity with youth and young adults, leading to the encouragement of their use in classrooms (Manning, 2010). Incorporating graphic novels into curriculum can help encourage adolescents to read and engage with media that utilizes a concise writing style with a visual impact they are used to consuming. Bakis (2012) emphasized that graphic novels can serve as an effective educational tool for developing literacy, critical thinking, and problem-solving, making it a strong candidate as a learning tool to correct misconceptions of microbes as it combines different learning theories and pedagogies.

Addressing microbiology misconceptions early in students’ education is essential for fostering scientifically informed attitudes toward health, the environment, and society. As shown in Figure 1 below, microorganisms are integral to every system on Earth, so having an informed

and holistic view of their role serves to strengthen our communities and environment. Misconceptions about microorganisms can negatively influence antimicrobial use, vaccine acceptance, and infection prevention practices, while also discouraging interest in science and STEM-related fields. Determining the efficacy of graphic novels as an instructional tool would provide teachers with an engaging and accessible way to present concepts that encourages curiosity, comprehension, and retention. This educational approach also aligns with the One Health framework by emphasizing the interdependence of human, animal, and environmental health, helping students develop a holistic understanding of the critical roles microorganisms play in sustaining life and global health (One Health Initiative, 2017).

Figure 1

One Health and Microorganisms diagram – how microbes substantially connect all life on Earth and the very ecosystem we live in. (Adapted from Couradeau et al., 2025⁵)



Materials and Methods

Creating the Graphic Novel and Power Point Presentation

The basis of this project is to evaluate the efficacy of a graphic novel as a learning tool in microbiology education. The learning tool we chose as a control to compare our graphic novel results to, was a presentation with a Power Point slide deck. We chose this control format as it is the most common lesson format our research team has encountered, both as students and as teachers. To have authority over the content in both tools, we had to create both from scratch. We started by consulting with Dr. Cheeptham to decide on the main ideas to include in novel and presentation. The following questions were addressed:

- Are microbes our friends or enemies?
- What are they and what do they look like?
- Where do they live?
- What do they do?
- How do we reframe our relationship with them?

We also wanted to emphasize sharing information from a global context, including exploring different cultures, destinations, and habitats. In summary, we wanted to present microorganisms as essential, diverse, and interconnected components of life rather than only as harmful and disease-causing.

Once we decided on the content of the graphic novel and presentation, we started to storyboard the book. Starting with the graphic novel was more intuitive as it was easier to create a cohesive story and make the presentation from the story, rather than make the presentation and try to draw a story out of its contents. To organize the storyboard, we utilized Canva to hold individual panels containing general information on plot point, setting, and sometimes

rudimentary sketches. After the story was mapped, I started to design the main characters of our story, Lily and Max. It took a few iterations of their designs, but I settled on an art style that fit the target age range of our readers and was easy to replicate and draw in different positions.

Figure 2 shows the initial character designs and Figure 3 shows their final designs.

Figure 2

Initial character designs for Lily (left) and Max (right) from “Microbe Mysteries”

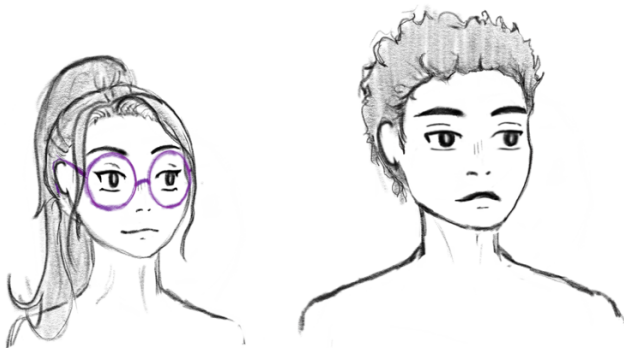
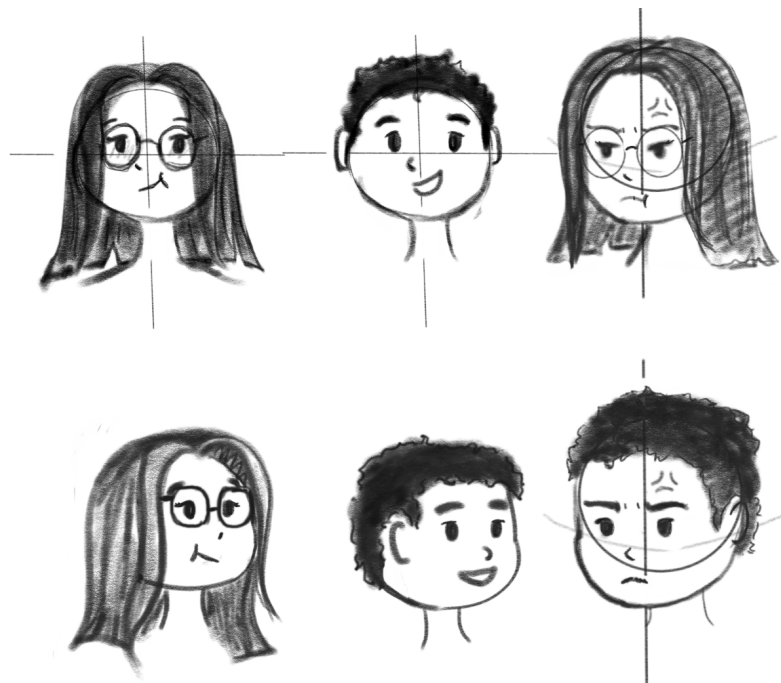


Figure 3

Final character designs for Lily and Max from “Microbe Mysteries”



Creating the dialogue from the storyboard was Keilin Gorman's job, our collaborator from UBC Faculty of Medicine. He wrote the dialogue based off our story board panels, using a tone and style like that of our target audience of middle school children. After consulting with some community collaborators, we received some feedback that we included some challenging vocabulary that may be beyond the reading level of grade 5 students, who were being considered the lower end of our target audience. This collaborator then suggested we include a glossary at the end of the book or have definitions at the bottom of the page so students can quickly find the meanings of new words or phrases. The "Word Explorer" at the back of the book was adapted from this initial feedback, and Keilin worked to translate the scientific definitions and explanations of microbiology concepts into a younger reading comprehension level.

After getting feedback from these collaborators and Dr. Cheeptham, I started to work on drawing the thumbnail sketches of each panel. The thumbnails were pencil sketches made on my iPad in order to determine the layout of the page and the types of images we wanted to accompany the dialogue. Once each page was sketched, I proceeded to add colour, small details, and ink work to polish the images. Figure 4 shows an example of a thumbnail sketch with the coloured panel next to it, which demonstrates the process I followed for every page. The free Sketchbook app on an iPad with an Apple Pencil was used for all the drawings in the book, including the front cover. The brushes within the Sketchbook app were limited to a No.6 pencil in different line thicknesses, an eraser, and occasionally an airbrush.

Figure 4

Example of a thumbnail sketch panel and fully coloured panel from “Microbe Mysteries”

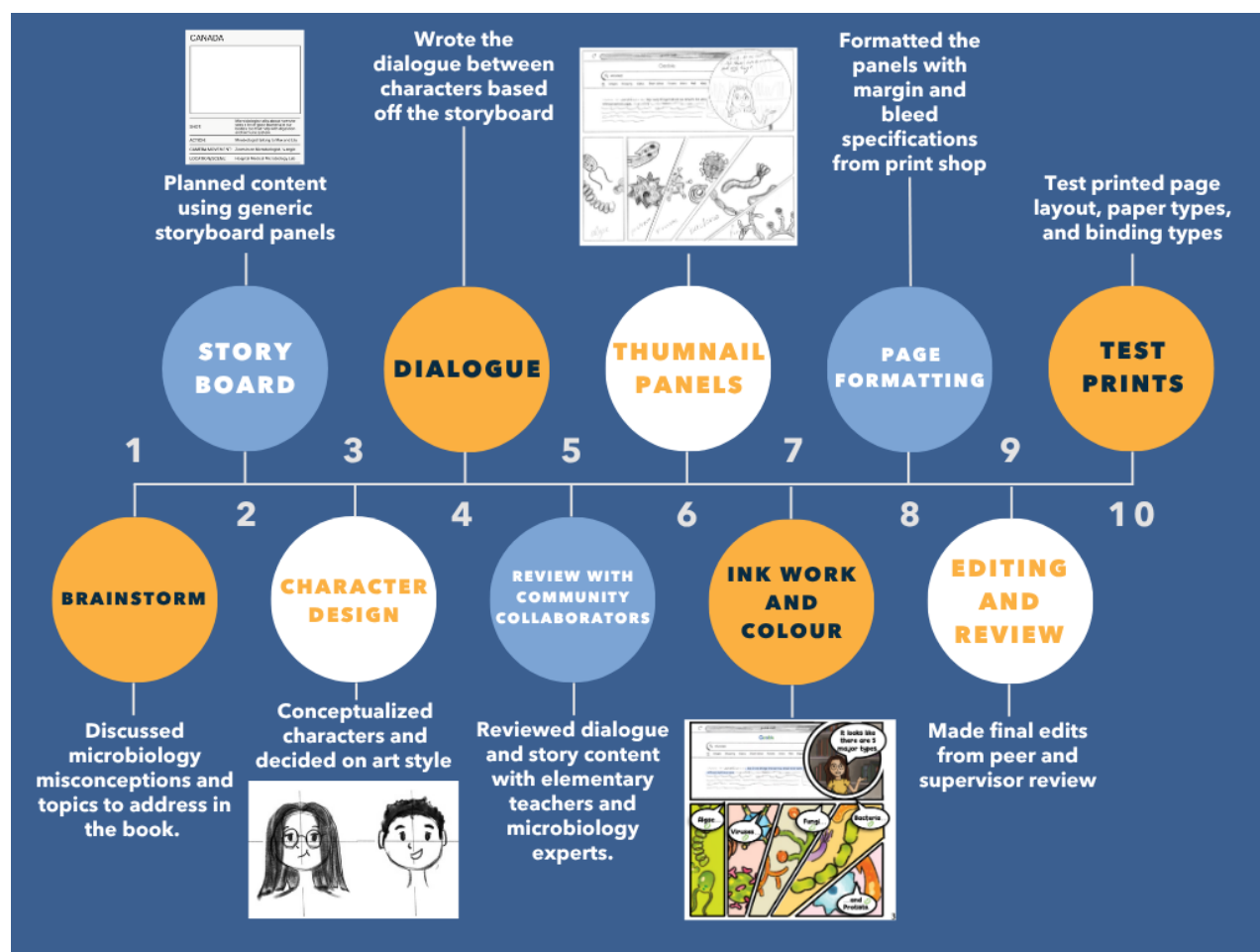


The graphic novel panels were formatted in Microsoft Power Point. This application was chosen as we could specifically control the paper size and precisely align book elements. The paper size, trim, and bleed were originally chosen in accordance with industry standards for graphic novels. We started with a paper size of 6.876”x10.438” with a trim of 6.625”x10.187” and a live area of at least 0.25” from the trim. After consulting with some print shops who would be able to print copies of our graphic novel, we decided to size our book to optimize printing efficiency. The paper size was changed from the original dimensions outlined above to that of approximately half of an A4 size with dimensions of 4.44” x 5.92”. We did not change the live area of the page, still keeping it within 0.25” from the trim. Following the page formatting, we added in speech bubbles with Keilin’s dialogue to complete each page.

The final step before we sent off the draft of our graphic novel was to get it reviewed by Dr. Cheeptham and other community collaborators. This was an integral step in our design and creation process as we were able to fix mistakes before a hard copy of the book was printed. Despite our numerous reviewers and all of the eyes we have had on it, there are still things we catch many months later. We have an ongoing relationship with the shops printing our graphic novel as the latest version is continually updated. A summary of this graphic novel writing process is shown in Figure 5 below. The graphic novel is included in Appendix A.

Figure 5.

Overview of graphic novel design process.



The Power Point presentation was easier to create. We took note of the specific concepts we covered in the graphic novel and translated those onto a Power Point presentation. This presentation was meant to be “realistic”, meaning that we wanted it to be representative of a slide deck a teacher would use in their class. This included images, easy-to-read points, and a variety of slide types.

Study Population

Our study population included Grade 9 students in School District #23. This grade was chosen for this pilot study since they encompass the target age range of the graphic novel as well as the timing of introducing microbiology-related content in the BC curriculum. Microbiology is first mentioned in the Science 8 curriculum with content covering the immune system, antibiotics, vaccines, and outbreaks (The Government of British Columbia, 2025). We thought it would be interesting to compare the data collected from participants both before and after microbiology is taught in the BC curriculum, allowing us to evaluate the impact that prior learning has on engagement and understanding.

Participating classrooms were randomly assigned to one of two groups:

1. Intervention Group: Students were read the graphic novel by the research team and were provided with copies to follow along and view the illustrations.
2. Control Group: Students received the same information through a standard PowerPoint presentation delivered by the research team.

Teachers were consulted prior to data collection to determine if there were any students who should be excluded from the learning activity such as those with Individualized Education Plans that might have difficulty following instruction.

Questionnaire Design

The pre- and post-questionnaires were designed to utilize quantitative and qualitative data to provide a comprehensive data set to analyze. The quantitative aspect focuses on analyzing Likert-scale survey responses to assess changes in student attitudes toward microorganisms and evaluate the instructional method they were given. Using a self-reporting tool like a Likert-scale allows us to measure unobservable concepts in students (Jebb, Ng, & Tay, 2021). To accommodate our age group, we used a simplified scale containing three options, “Disagree”, “I Don’t Know”, and “Agree”. We decided to use “I Don’t Know” as it is more colloquial for a student to see that rather than “Neutral”. In our data analysis, we interpreted an “I Don’t Know” response as truly neutral, meaning that the student was undecided between answering “Disagree” or “Agree”. Because of this interpretation, we are assuming that this quantitative data is a sliding scale of values rather than discrete answers for the purposes of analysis. The three answer options are associated with a numerical value to complete the statistical analysis: 0 = “Disagree”, 1 = “I Don’t Know”, and 2 = “Agree”. Each question was designed to address key objectives of our study:

- Q1: Multimodal learning
- Q2: Microbe Misconceptions
- Q3: Importance of Microbes
- Q4: Interest in Microbiology
- Q5: Efficacy of Instructional Method

The questions remain the same in the pre- and post-questionnaires, only the tense changed to reflect the time the question was asked. For example, “I think reading a graphic novel

will help me remember the information better,” in the pre-questionnaire versus, “Reading a graphic novel helped me remember the information,” in the post-questionnaire.

Similarly, the qualitative component examines short written responses for shifts in conceptual understanding and to provide context to previous student explore to microbiology concepts. The first short answer question on the pre-questionnaire asks the students about their baseline knowledge about microorganisms that we compare to the corresponding question on the post-questionnaire asking students what one new thing they learned about microbiology. The second two questions are less related to each other across pre and post. In the pre-questionnaire, questions 7 and 8 asks students to reflect on their first experience learning about microbes, specifically at what age and where. We wanted to ask this question so we could see if this data corresponds to the BC Science Curriculum guidelines when microbiology first appears. In the post-questionnaire, we asked students to reflect on their positives and negatives about the graphic novel/ presentation so we could gauge their interest in their lesson delivery method.

The pre-questionnaires and post-questionnaires are the same between both instructional methods, only the language shifts between graphic novel and presentation depending on which one the students receive. We wanted to make the questionnaires accessible for readers in the classes we go to, so they are a single page with 8 questions containing simple language. The questionnaires are also reviewed with the students before they complete it and they are free to ask questions about words and meaning of questions while answering them. The questionnaires are included in Appendix B.

Consent and Recruitment

Participants were recruited through outreach in schools by administrators or directly with teachers. Posters and verbal information contained the aim of the study, inclusion criteria, location, name of primary investigator and a TRU email account and phone number the classroom teachers could contact if interested.

Before participating, students were given an opt-out permission slip to get informed consent from their parents or guardians. The form given to parents had a brief description of the aims of study and the purpose of the research we were conducting. We outlined the procedures for collecting the data and what would be happening in their students' class. The form also included sections on the risks and benefits, costs and compensation, duration of participation, voluntary participation, confidentiality, data security, and privacy policies. The form provided parents or guardians with a comprehensive view of the anonymous role their students would assume, that their role would not deviate from what they normally do in their classroom, and that their participation is voluntary. This form was distributed to participating classrooms at least two weeks prior to the research activity.

Since the participants are minors and therefore not able to provide fully informed consent on their own, their parents or guardians provided consent on their behalf. We used an opt-out (passive consent) process to reduce administrative burden, while still ensuring families are fully informed. Parents/guardians received a consent form outlining the aims and purpose of the study, the classroom procedures, risks and benefits, costs and compensation, duration, voluntary participation, confidentiality, data security, and privacy. This ensured they have a comprehensive understanding of the study and their students' role. Students were also informed verbally in class

that participation is voluntary, anonymous, unrelated to their grades, and that they may withdraw at any time prior to submitting their questionnaires.

If a student withdraws from the study prior to data collection, then they will not complete any of the questionnaires and, depending on the nature of the withdrawal, be removed from class for the duration of the research activity. A student cannot withdraw from the study after the questionnaire has been collected as their responses are anonymous and we would not be able to identify their responses to be removed from the study after collection.

Students were informed of everything that was required of them prior to the research, but no leading questions or statements about the benefits of microbes were shared before students complete the pre-test to avoid any skewing of results. Prior to the start of the study, students were informed that we were conducting our study to see whether a graphic novel is a better teaching tool than direct instruction for microorganisms, but the contents of the lesson were not shared with students beforehand. Teachers, Parents/Guardians, and School Administrators were made aware of the full contents of the lesson, study questionnaires, and activities prior to the research.

The consent forms, outreach letter, outreach poster, student assent form, and teacher information letter are included in Appendix C.

Lesson Delivery

Each research session took approximately 40 minutes, including a 10-minute pre-lesson questionnaire, a 20-minute lesson, and a 10-minute post-lesson questionnaire. Lessons were conducted by the research team to ensure consistency in delivery, tone, and engagement across

all classrooms. The lesson plan for the entire session, including the activities after data collection, is outlined below.

Brief Lesson Plan (Approx. 60 Minutes Total)

1. Pre-Lesson Questionnaire (10 minutes)

Students complete a short, anonymous questionnaire to share what they currently know and think about microorganisms.

2. Microbiology Lesson (20 minutes)

- Either a guided reading of the graphic novel *or*
- A traditional presentation with discussion

Topics include:

- What microorganisms are
- Common misconceptions
- Helpful roles of microbes in the human body and the environment

3. Post-Lesson Questionnaire (10 minutes)

Students complete a second questionnaire similar to the first to measure changes in understanding and attitudes.

4. Hands-On Microbiology Activities (15–20 minutes)

As a thank-you for participation, students engage in fun, interactive microbiology-related activities led by the research team. The activities will be a handwashing activity using Glow Germ and a matching activity with plush Giant Microbes.

It is also important to connect how our research relates to the BC Core Competencies as well as the BC Science Curriculum. The Core Competencies are proficiencies that can be

developed in any curricular area to develop Communication, Thinking, and Personal and Social competencies in students. This lesson relates to the Personal and Social competency because students consider how microbiology concepts relate to human health, environmental systems, and community well-being. Completing the pre and post questionnaires encourages students to recognize their role as contributors to a shared learning community and to reflect on how scientific understanding can inform responsible decision-making in real-world contexts. Students also develop their Critical and Reflective Thinking as they respond to pre and post questionnaires, they analyze their understanding of microbiology concepts before and after instruction. This process requires them to make judgments about their own learning, identify shifts in understanding, and evaluate how instructional approaches influenced their engagement with the material. Students reflect on their learning experiences by comparing their initial ideas with their post-lesson understanding. The questionnaires support reflection by prompting students to assess how their thinking has changed, how engaged they felt during the lesson, and which aspects of the learning experience supported their understanding of microbiology.

Data Analysis

The overarching methodological approach for this project is quantitative with qualitative components, making it a mixed-methods pilot study. The quantitative aspect focuses on analyzing Likert-scale survey responses to assess changes in student attitudes toward microorganisms, while the qualitative component examines short written responses for shifts in conceptual understanding.

Quantitative questionnaire responses were summarized using descriptive statistics such as mean, median, interquartile range, and a paired t-test to provide an overview of student attitudes

and knowledge before and after the lesson. To test for differences, we used a t-test to assess the differences between the two instructional methods while also looking at the change from pre-instruction to post-instruction. We wanted to evaluate the differences in answers between the graphic novel and direct instruction groups while seeing if the students within those groups are all improving in a similar way.

Qualitative short-answer responses will be coded thematically in further studies to identify common patterns such as misconceptions, curiosity, or recognition of microbial benefits. For this pilot study, we will share some examples of answers to written responses that highlight some of the positive feedback we have received from students. Together, these approaches will provide a mixed-methods understanding of how different teaching resources influence student knowledge, attitudes, and engagement.

Ethics Application and Approval

In order to conduct our study, we had to gain approval from the TRU Human Research Ethics Committee. After applying for ethical approval, we learned that since our project includes a collaborator from the University of British Columbia, we must seek a Harmonized Ethics Review on the UBC RISE platform to gain ethics approval. The approval letter and application are included in Appendix D.

Results

Graphic Novel

The quantitative data collected from the questionnaires come from the numerical values associated with basic Likert-scale questions. The statistical analysis conducted on the data collected from each question is included in Table 1 below.

Table 1. *Statistical analysis of quantitative graphic novel questionnaire data in grade 9 students (n=27).*

Question	Pre-Graphic Novel			Post-Graphic Novel			<i>p</i>
	<i>M</i>	<i>Mdn</i>	<i>IQR</i>	<i>M</i>	<i>Mdn</i>	<i>IQR</i>	
Q1: Pictures and words together help me understand the lesson better ^a	1.963	2	0	1.852	2	0	0.0830
Q2: Microorganisms (like bacteria and viruses) are mostly harmful and dangerous ^a	1.222	1	1	0.185	0	0	$2.45 \times 10^{-6*}$
Q3: Microorganisms are important for the health of humans and the environment ^a	1.778	2	0	1.926	2	0	0.103
Q4: I am curious about microbiology ^a	1.481	2	1	1.740	2	0	0.109
Q5: Reading a graphic novel helped me remember the information ^a	1.556	2	1	1.778	2	0	0.056

Note. Number of participants = 27; *M* = mean, *Mdn* = median, *IQR* = Interquartile Range.

^a 0 = Disagree, 1 = I Don't Know, 2 = Agree.

**p*<0.05.

Direct Instruction (Power Point)

Similarly to the graphic novel group, the students given direct instruction answered Likert-scale questions which provided quantitative data. This data set was subjected to the same statistical analysis including mean, median, interquartile range, and a t-test as shown in Table 2.

Table 2. *Statistical analysis of direct instruction questionnaire data in grade 9 students (n=18).*

Question	Pre-Graphic Novel			Post-Graphic Novel			<i>p</i>
	<i>M</i>	<i>Mdn</i>	<i>IQR</i>	<i>M</i>	<i>Mdn</i>	<i>IQR</i>	
Q1: Pictures and words together help me understand the lesson better ^a	1.667	2	1	1.556	2	0.75	0.495
Q2: Microorganisms (like bacteria and viruses) are mostly harmful and dangerous ^a	0.611	1	1	0.556	0	1	0.790
Q3: Microorganisms are important for the health of humans and the environment ^a	1.889	2	0	1.889	2	0	1
Q4: I am curious about microbiology ^a	1.000	1	0	1.278	2	1.75	0.0962
Q5: Getting a presentation on microbiology helped me remember the information ^a	1.222	1	1	1.500	2	1	0.172

Note. Number of participants = 18; *M* = mean, *Mdn* = median, *IQR* = Interquartile Range.

^a 0 = Disagree, 1 = I Don't Know, 2 = Agree.

**p*<0.05.

Comparative Analysis

A t-test was used to compare questionnaire data between the two instructional methods in Table 3. The questions on the graphic novel and direct instruction questionnaires were compared between the graphic novel lesson and the direct instruction lesson. By comparing the pre-instruction data and the post-instruction data between the lessons, we aim to see a holistic picture of the statistical significance of pre- and post-instruction data to make meaningful observations about the tool used in the lesson.

Table 3. *Statistical analysis of quantitative direct instruction questionnaire data and graphic novel questionnaire data (n=45).*

Question	Pre-Lesson	Post-Lesson
	<i>p</i>	<i>p</i>
Q1: Pictures and words together help me understand the lesson better ^a	0.0257	0.160
Q2: Microorganisms (like bacteria and viruses) are mostly harmful and dangerous ^a	0.00452*	0.117
Q3: Microorganisms are important for the health of humans and the environment ^a	0.325	0.690
Q4: I am curious about microbiology ^a	0.0237	0.0590
Q5: Getting a presentation/reading a graphic novel on microbiology helped me remember the information ^a	0.152	0.147

Note. Number of participants = 45;

^a 0 = Disagree, 1 = I Don't Know, 2 = Agree.

* $p < 0.05$.

Discussion

Graphic Novel

The data shown in Table 1 shows the most noticeable changes in Question 2 responses after the graphic novel as the average answer shifted from 1.222 to 0.185. It is important to note that the mean value shows subtle shifts in responses. The median answer shows the typical student response which shifted from “I Don’t Know” to “Disagree” when asked if microorganisms are mostly harmful and dangerous. The consensus among the group also increased as supported by the interquartile range dropping from 1 before the graphic novel, and 0 after the graphic novel. This change in microbiology misconceptions was statistically significant ($p=2.45 \times 10^{-6}$).

Question 1 showed a decrease in average response from 1.963 to 1.851 when asked if pictures and words helped them understand the lesson better. Questions 4 and 5 showed an average increase in microbiology curiosity and the benefits of the graphic novel in understanding the information. Question 4’s average answer increased from 1.481 to 1.740 with an increase in consensus among the group as the IQR dropped from 1 to 0, suggesting an increase in microbiology curiosity after reading the graphic novel. Similarly, Question 5 showed an increase in average answer from 1.556 to 1.778 with an increase in consensus as well since the IQR shifted from 1 to 0. This data contradicts the findings from Question 1 that showed a slight decrease in students thinking the pictures and words together helped them understand the information since there is an increase in students thinking reading the graphic novel helped them remember the information better. Although there is not a statistical significance in the changes observed in the responses in questions 1, 3, 4, and 5, the subtle shifts might become more apparent with greater sample sizes in future studies.

Direct Instruction

The data collected from the group of grade 9 students who received that Power Point presentation, or direct instruction, is shown in Table 2. There is no statistical significance in answers before and after the instruction as illustrated by the p-values. The most profound finding from this data set is in the answers to Question 3, “Microorganisms are important for the health of humans and the environment”. The average answer to this question was “2 - Agree” with the same mean value of 1.889 both pre-instruction and post-instruction. This finding suggests the strength of this group’s previous microbiology knowledge, as they already understood the importance and benefits of microbes prior to the lesson. While the data from Question 3 does not have statistical significance, it still provides some valuable insight into the attitudes and previous knowledge of this group of students.

The results from Question 2 did not have the same significance as the graphic novel group, but it is still important to notice the median answer changed from “1 – I Don’t Know” to “0 – Disagree” when asked if Microbes are mostly harmful and dangerous. Additionally, there was an overall increase in microbiology curiosity and value of getting the presentation from Questions 4 and 5, but there is no statistical significance to these changes. This further reinforces the need to a greater sample size of students when conducting later studies.

Comparative Analysis

To compare the two learning tools, a t-test was conducted on the pre- and post-instruction questionnaire data sets from the graphic novel and direct instruction groups as shown in Table 3. The only value that showed statistical significance was from Question 2 from the pre-instruction questionnaires ($p=0.00452$). This was not a value we are interested in looking at, as we are

concerned with comparing the post-instruction statistics of the instructional methods. There was no statistical significance between the two outcomes when analyzing the quantitative data.

When looking at the baseline knowledge of microbiology misconceptions measured through Question 2, the graphic novel group had greater initial misconceptions about microbes to begin with over the direct instruction group so the change in attitudes with the post-instruction questionnaire was more noticeable. The mean answer from the graphic novel group was 1.22 while the direct instruction group was 0.661. Both of the values lowered in the post-instruction questionnaire, but the direct instruction class had a different baseline knowledge, so it is difficult to compare the instructional methods against each other.

Qualitative Answers

Given the nature of this research, we wanted to ensure we were capturing the nuanced and individualized perspectives of the participants beyond the Likert scale responses so included short answer questions in the survey. As mentioned, we will be coding the responses for more objective analysis in later steps of the project, however, we wanted to share a few notable responses from after the graphic novel lesson in this report.

Table 4. *Notable Participant Short-Answer Responses Post Graphic Novel.*

What is one new thing you learned about microorganisms today?	What part of the graphic novel helped you learn about microbiology? Why?
<i>“Not all bacteria are bad, and some can actually help us live.”</i>	<i>“I liked the pictures because they make me have a better understanding on how things work.”</i>

<i>“There are different groups, each doing its own thing. Also, learned that microorganisms have different shapes/how to identify.”</i>	<i>“I liked the drawings and how there was a word bank at the end of the book.”</i>
<i>“Microorganisms (microbes) live in our food! They can also live in extreme places like a volcano or glacier.”</i>	<i>“Pictures and words because pictures help me understand best and they were drawn really well and the words made sense with them.”</i>

Overall, the written feedback from the participants about the graphic novel was encouraging. Almost every student reported learning something new from the graphic novel. As shown in the first column of Table 4, many of the responses included interest where microbes can be found, how microbes are used in food, and that although some cause infection, the vast majority of beneficial to the health of humans and the environment. The participants also noted how helpful the graphic novel was. The comments in the second column of Table 4 represent some common responses from the students about the graphic novel. They especially emphasized how useful the illustrations were in improving the understanding of the microbiology concepts. Likewise, students commented that the word index at the back of the book was helpful to supplement their learning as they read through the book.

Researcher Observations

After each research session, I wrote a journal entry detailing my experience and feelings while conducting research in the class. Below is the reflection I wrote after conducting the research session with the grade 9 class who received the graphic novel instruction:

I stayed at the front of the class the entire time to read the novel aloud and projected the pages onto the front screen instead of walking around the room. Even though this initial part of the lesson had no direct student participation, the students seemed excited to see the graphic novel and immediately started flipping through the pages. As I read, they followed along closely in their own copies, and I even noticed a few of them proactively utilizing the word explorer in the back of the book. The class was engaged throughout the whole process, which was reflected in the quality of their answers and the depth of the questions they were asking. In fact, out of the 27 students present, every single one completed the questionnaire on their own. This included one student with one-to-one certified educational assistant (CEA) support, whose CEA transcribed the answers to ensure the data truly represented the student's own thinking. The excitement continued when the lesson ended either, as students actually came to find me after the research session to talk about how interested they were about the concepts introduced in the graphic novel. They were even telling their other friends about where to find microbes. Overall, I had excellent participation during the entirety of the session and it was a wonderful experience.

I also wrote a reflection after my research session with the grade 9's who received the direct instruction Power Point:

For this session, I followed the presentation slides and tried to spark some interest by asking the group questions as I went through them, such as asking who had heard of microbes before or what they thought would happen if all the microbes disappeared from the Earth. However, I noticed almost immediately that engagement was poor with this group. To improve this, I

tried to deliver the presentation as I naturally would while teaching my own class outside of a research setting, even walking around the room with a Bluetooth clicker to try and keep their attention. Despite these efforts, participation was limited, and it was difficult to even get the students to look at me or the board. Many of them were not looking at the presentation at all, and the few interruptions I did get were mostly off-topic questions. They just seemed completely indifferent to my presence, which was a contrast to the graphic novel group who had greeted me so warmly. This stark difference is definitely something to explore later, and it might be a strong indicator that we need many more data sets to get a true picture of student attitudes toward the presentation versus the graphic novel.

From these two reflections, it is clear to see a difference in class attitude and engagement between the two groups. It is difficult to conclude whether this is due to the type of instruction they were receiving or simply the composition of students in the class and their personal attitudes towards science and microbiology. Once again this highlights the importance of needing a larger sample size to get a better idea of the significance of each instructional method.

Conclusion

The aim of this research project was to explore the efficacy of graphic novels as a learning tool to enrich microbiology literacy and interest in school-aged students. After conducting our study in two grade 9 classes, our data suggested the graphic novel had a statistically significant impact on dispelling microbiology misconceptions as was supported by the qualitative student feedback on the benefits of the graphic novel for their understanding. The

control group that received the direct instruction through a Power Point presentation showed no statistical significance before and after the lesson they received.

The two classes were vastly different in composition, class size, and overall attitude and engagement, so gathering additional participant groups' data would be necessary to get a stronger representation of the average student. In future studies, a greater sample size would be beneficial as well as an amendment to the questionnaires themselves. I realized while conducting this study that some of the questions repeated or didn't directly answer our research objectives. Updating those questions to better characterize and synthesize the aims of the research will lead to more meaningful data analysis in the future.

I learned many things from this pilot study that greatly informed the future directions for this research. The first being time, as writing and illustrating a graphic novel was a substantial undertaking while conducting a research study and while being in the B.Ed. I also learned to budget as much time as possible for ethics applications and to not have a rigid project timeline. The prolonged ethics approval timeline ended up shifting our research timeline back by a few months so I could only have time to collect data from two classrooms. It also meant that the data collection period shifted to being during my qualifying teaching practicum, an extremely busy time to being with. Overall, I think the biggest lesson I am taking away from this project is that even if you are passionate about a project, building in time for flexibility and having backup plans is the best way to ensure you enjoy the entirety of the process and not get frustrated with shifting timelines.

Future Research/Directions

In the next few weeks, we will be conducting this research study in grade 5 classrooms. We will be evaluating the graphic novel and direct instruction Power Point presentation in this

younger age group to get a better idea of the appropriate ages for this study. After this research, we will compare the results of the Grade 5's and Grade 9's to see if there is a noticeable difference in responses and outcomes. Further ideas for future research include evaluating the classroom teacher's expertise in how microbiology content is delivered to students, and perhaps if there is a noticeable difference in the composition of classrooms on which learning tools are best.

Our research group is also expanding to reflect the growth in this project. I will be building off this pilot project to explore and evaluate microbiology teaching practices using objective analysis of observations and surveys with the graphic novel and presentation in the TRU M.Ed. program while completing my thesis. My thesis committee includes Dr. Cheeptham, and now Dr. Alana Hoare, and Dr. Gloria Ramirez. We also have new community partners including, Morgan Whitehouse with SD#73, Dr. Óscar Enrique Gómez Rodríguez from Universidad Nacional de Colombia, and Dr. Jen Tam, a pediatric infectious disease physician at BC Children's Hospital and a Clinical Assistant Professor at UBC. This research team will collaborate to develop a holistic and informative microbiology literacy project that utilizes the information found in this pilot project in the near future.

Microbe Mysteries, the graphic novel we created for this project, is also being translated into Thai, Vietnamese, Arabic, Chinese, French, Spanish, Hindi, Secwépemc tsin (west), Korean, Malayalam (Indian for Kerala), Sinhala, Creole, Polish, Bengali, Assamese, Kazakh, Russian, Yoruba, Japanese, German, Persian, and Urdu. We hope that we can make microbiology education even more accessible by making it available to the public in as many languages as possible. We are currently working to provide the graphic novel to local public schools and public libraries for free as an eBook and in print.

Funding

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Acknowledgements

I would like to first and foremost thank Dr. Naowarat Cheeptham for helping me develop my project, answering my questions, and teaching me how to be a better researcher. Her expertise and philosophy will be an ongoing support as I move into my M.Ed. at Thompson Rivers University. I would also like to thank Dr. Rob Wielgoz for being my co-supervisor and supporting my research endeavours while being in the Bachelor of Education program. Thank you to my research partner Keilin Gorman for his support, invaluable expertise, and continuing passion for this initiative. Dr. Alana Hoare has been instrumental in helping me develop my research materials and has provided valuable insight into the research process. I am grateful to have her support as I transition this project into a graduate thesis. Tasfia Ahsan has provided me with valuable insight, and I look forward to continuing to work with her as a teacher. I would like to express gratitude to John Simonson, my faculty mentor during my 10-week practicum in SD#23, for his support and initiative in helping get our project's approval in SD#23. Lastly, I am grateful to SD#23 and the administrators at the schools we conducted our studies in for their support and excitement in our study.

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Appendix A: Microbe Mysteries Graphic Novel

Link to graphic novel: [Microbe Mysteries \(May 2026\)](#)

Note must be signed into TRU account to view.

Link is used due to file size.

Appendix B: Questionnaires

Graphic Novel Pre Instruction Questionnaire

Grade: _____

Date: _____

- There are no right or wrong answers, and you will not be marked on your answers or your spelling.
- Your answers will be private and anonymous, which means no one will know what you wrote.
- Some questions will ask you if you agree or disagree with a statement. Circle your answer with the scale included below the question. If you are unsure just circle "I Don't Know".
- Some questions will ask you to write a short answer. Please write a few words or sentences in your own words.

Please answer all questions carefully. Your ideas will help teachers and researchers understand how students like you learn best.

1. Pictures and words together help me understand the lesson better.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

2. Microorganisms (like bacteria and viruses) are mostly harmful and dangerous.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

3. Microorganisms are important for the health of humans and the environment.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

4. I am curious about microbiology.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

5. I think reading a graphic novel will help me remember the information better.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

6. What do you already know about microorganisms (tiny living things like bacteria and viruses?)

7. When did you first learn about microorganisms like bacteria, fungi, algae, and viruses?

8. Did you learn about microorganisms at school, at home, through the news, or any other sources?

Graphic Novel Post Instruction Questionnaire**Grade:** _____**Date:** _____

- There are no right or wrong answers, and you will not be marked on your answers or your spelling.
- Your answers will be private and anonymous, which means no one will know what you wrote.
- Some questions will ask you if you agree or disagree with a statement. Circle your answer with the scale included below the question. If you are unsure just circle “I Don’t Know”.
- Some questions will ask you to write a short answer. Please write a few words or sentences in your own words.

Please answer all questions carefully. Your ideas will help teachers and researchers understand how students like you learn best.

1. I understand better when things are taught with pictures and stories.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

2. Microorganisms (like bacteria and viruses) are mostly harmful and dangerous.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

3. Microorganisms are important for the health of humans and the environment.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

4. The lesson today helped me feel more curious about microbiology.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

5. Reading a graphic novel helped me remember the information.

I Disagree	I Agree	I Don't Know
------------	---------	--------------

6. What is one new thing you learned about microorganisms today?

7. What parts of the graphic novel (like the pictures, words, or explanations) helped you learn about microbiology? Why?

8. What parts of the graphic novel (like the pictures, words, or explanations) did **not** help you learn about microbiology? Why?

DI Pre Instruction Questionnaire

Grade: _____

Date: _____

- There are no right or wrong answers, and you will not be marked on your answers or your spelling.
- Your answers will be private and anonymous, which means no one will know what you wrote.

- Some questions will ask you if you agree or disagree with a statement. Circle your answer with the scale included below the question. If you are unsure just circle “I Don’t Know”.
- Some questions will ask you to write a short answer. Please write a few words or sentences in your own words.

Please answer all questions carefully. Your ideas will help teachers and researchers understand how students like you learn best.

9. Pictures and words together help me understand the lesson better.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

10. Microorganisms (like bacteria and viruses) are mostly harmful and dangerous.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

11. Microorganisms are important for the health of humans and the environment.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

12. I am curious about microbiology.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

13. I think getting a presentation on microbiology will help me remember the information better.

I Disagree	I Agree	I Don’t Know
-------------------	----------------	---------------------

14. What do you already know about microorganisms (tiny living things like bacteria and viruses)?

15. When did you first learn about microorganisms like bacteria, fungi, algae, and viruses?

16. Did you learn about microorganisms at school, at home, through the news, or any other sources?

DI Post Instruction Questionnaire

Grade: _____

Date: _____

- There are no right or wrong answers, and you will not be marked on your answers or your spelling.
- Your answers will be private and anonymous, which means no one will know what you wrote.
- Some questions will ask you if you agree or disagree with a statement. Circle your answer with the scale included below the question. If you are unsure just circle “I Don’t Know”.
- Some questions will ask you to write a short answer. Please write a few words or sentences in your own words.

Please answer all questions carefully. Your ideas will help teachers and researchers understand how students like you learn best.

9. I understand better when things are taught with pictures and stories.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

10. Microorganisms (like bacteria and viruses) are mostly harmful and dangerous.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

11. Microorganisms are important for the health of humans and the environment.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

12. The lesson today helped me feel more curious about microbiology.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

13. Getting a presentation on microbiology helped me remember the information.

I Disagree	I Agree	I Don't Know
-------------------	----------------	---------------------

14. What is one new thing you learned about microorganisms today?

15. What parts of the presentation (like the pictures, words, or explanations) helped you learn about microbiology? Why?

16. What parts of the presentation (like the pictures, words, or explanations) did **not** help you learn about microbiology? Why?

Appendix C: Consent and Recruitment Materials

Teacher Participation Letter:

Dear [Teacher's Name],

Thank you for welcoming our research team into your classroom. We truly appreciate your willingness to support educational research and innovative approaches to teaching science. Below is an overview of what participation in the study involves, including a summary of the consent process, a brief lesson outline, and what you can expect after the research session is complete.

Overview of the Research Study

This study, *From Gram Stains to Graphic Novels: Researching a New Way to Teach Microbiology*, explores whether a graphic novel is an effective tool for teaching students about microorganisms compared to a traditional presentation format. Many students develop early misconceptions that microbes are only harmful, despite their essential role in health, ecosystems, and everyday life. This project aims to introduce microbiology concepts earlier and in a more balanced, engaging way.

Your class will be **randomly** assigned to receive either:

- A short lesson using a microbiology-themed graphic novel, or
- A short lesson using a traditional teacher-led presentation covering the same content

Both formats deliver identical core concepts and are facilitated by the research team.

Summary of the Consent Form (for Teachers)

- **Participation is voluntary** for all students.
- We will provide an **opt-out consent form** for you to distribute to your class.
- We also ask that you distribute this form by email to your students' parents/guardians.

- Students whose parents opt them out will not participate in any data collection, but they can still participate in the activities we do in the class.
- No student names are collected; all questionnaires are **anonymous** and will not affect grades.
- The questionnaires assess students' **knowledge, attitudes, and curiosity** about microorganisms.
- There are **no foreseeable risks**, and all content is age-appropriate and teacher-approved.
- Data is securely stored and used only for research, presentations, and publications related to education and microbiology.

Brief Lesson Plan (Approx. 60 Minutes Total)

1. Pre-Lesson Questionnaire (10 minutes)

Students complete a short, anonymous questionnaire to share what they currently know and think about microorganisms.

2. Microbiology Lesson (20 minutes)

- Either a guided reading of the graphic novel *or*
 - A traditional presentation with discussion
- Topics include:
- What microorganisms are
 - Common misconceptions
 - Helpful roles of microbes in the human body and the environment

3. Post-Lesson Questionnaire (10 minutes)

Students complete a second questionnaire similar to the first to measure changes in understanding and attitudes.

4. Hands-On Microbiology Activities (15–20 minutes)

As a thank-you for participation, students engage in fun, interactive microbiology-related activities led by the research team. The activities will be a handwashing activity using Glow Germ and a matching activity with plush Giant Microbes.

How the Lesson Relates to BC Curriculum Core Competencies

Personal and Social: Social Awareness and Responsibility

- **Contributing to community and caring for the environment:**
Through participation in the research study, students consider how microbiology concepts relate to human health, environmental systems, and community well-being. Completing the pre and post questionnaires encourages students to recognize their role as contributors to a shared learning community and to reflect on how scientific understanding can inform responsible decision-making in real-world contexts.

Thinking: Critical and Reflective Thinking

- **Analyzing and critiquing:**

As students respond to pre and post questionnaires, they analyze their understanding of microbiology concepts before and after instruction. This process requires them to make judgments about their own learning, identify shifts in understanding, and evaluate how instructional approaches influenced their engagement with the material.

- **Reflecting and assessing:**

Students reflect on their learning experiences by comparing their initial ideas with their post-lesson understanding. The questionnaires support metacognition by prompting students to assess how their thinking has changed, how engaged they felt during the lesson, and which aspects of the learning experience supported their understanding of microbiology.

What to Expect After the Research Session

- Your class will receive letters of thanks acknowledging their participation.
- Your class will also get a copy of the graphic novel regardless of the type of instruction your class receives.
- You may request updates or a summary of the study findings once the research is complete.
- Results may contribute to academic publications and presentations aimed at improving science education, but no identifying information will ever be shared.
- We are happy to discuss follow-up lessons, resources, or extensions related to microbiology if desired.

We are grateful for your time, support, and collaboration. If you have any questions before or after the session, please feel free to contact us.

Sincerely,

Dr. Naowarat Cheeptham (Ann)

Principal Investigator
Ncheeptham@tru.ca

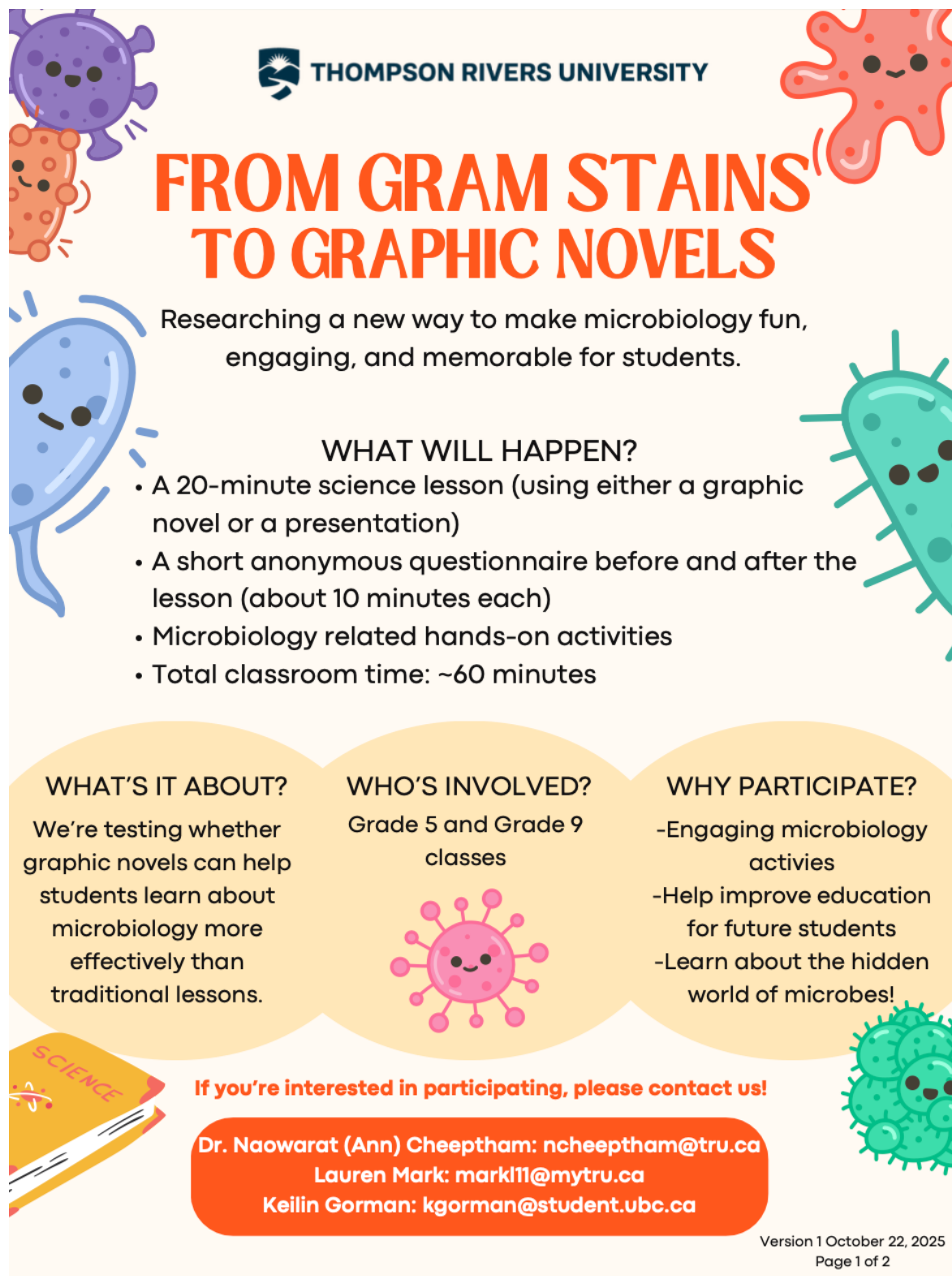
Lauren Mark

Undergraduate Researcher
markl11@mytru.ca

Keilin Gorman

Medical Student Researcher
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Outreach Letter and Poster:



 **THOMPSON RIVERS UNIVERSITY**

FROM GRAM STAINS TO GRAPHIC NOVELS

Researching a new way to make microbiology fun, engaging, and memorable for students.

WHAT WILL HAPPEN?

- A 20-minute science lesson (using either a graphic novel or a presentation)
- A short anonymous questionnaire before and after the lesson (about 10 minutes each)
- Microbiology related hands-on activities
- Total classroom time: ~60 minutes

WHAT'S IT ABOUT?

We're testing whether graphic novels can help students learn about microbiology more effectively than traditional lessons.

WHO'S INVOLVED?

Grade 5 and Grade 9 classes

WHY PARTICIPATE?

- Engaging microbiology activities
- Help improve education for future students
- Learn about the hidden world of microbes!

If you're interested in participating, please contact us!

Dr. Naowarat (Ann) Cheeptham: ncheeptham@tru.ca
Lauren Mark: markl11@mytru.ca
Keilin Gorman: kgorman@student.ubc.ca

Version 1 October 22, 2025
Page 1 of 2

Purpose of the Study:

Our project aims to explore innovative ways to engage students in science. We are investigating whether a graphic novel can be an effective tool for teaching students about microbiology, specifically to address common misconceptions and foster a more holistic understanding of the beneficial roles microorganisms play in our world.

Proposed Methodology:

The study would involve delivering a 20-minute lesson on microorganisms to participating Grade 5 and Grade 9 classrooms. Half of the classes would be randomly selected to receive the lesson with the graphic novel, while the other half would receive the same information through a standard direct instruction presentation. Before and after the lesson, students would complete a short, anonymous 10-minute questionnaire about their understanding and attitudes. The entire research process would take approximately 30–45 minutes per class. Our research team would be the ones delivering the content, as well as delivering some fun microbiology activities as a form of compensation to the class for their participation. In total with the research and activities, each session would be around 60 minutes.

Consent Process:

Before participating, students will be given an opt-out permission slip to get informed consent from their parents or guardians. The form given to parents will have a brief description of the aims of study and the purpose of the research we are conducting. We will outline the procedures for collecting the data and what will be happening in their students' class. The form will also include sections on the risks and benefits, costs and compensation, duration of participation, voluntary participation, confidentiality, data security, and privacy policies. The form will provide parents or guardians with a comprehensive view of the anonymous role their students will assume, that their role does not deviate from what they normally do in their classroom, and that their participation is voluntary. This form will be distributed to participating classrooms at least two weeks prior to the research activity.

*Consent Form***Informed Consent Form*****From Gram Stains to Graphic Novels: Researching a New Way to Teach Microbiology*****Principal Investigator:** Dr. Naowarat Cheeptham (Ann)**Undergraduate Researcher:** Lauren Mark**Collaborator:** Keilin Gorman**PURPOSE**

The purpose of this study is to explore whether a graphic novel is an effective way to teach students about microorganisms compared to traditional instruction. Many children grow up with misconceptions about microbes, often seeing them only as harmful, even though they play an essential role in health, the environment, and life on Earth. Because microbiology is not introduced in the curriculum until later grades, we want to see if presenting this material earlier through a graphic novel can help students better understand and develop a more balanced perspective. In this pilot study, some classrooms will learn using the graphic novel while others will receive a presentation with the same content. The presentation format was chosen as the comparison condition because it reflects a common, teacher-led instructional method currently used in classrooms, allowing us to directly compare a familiar teaching approach with the new graphic novel format. Students will complete short questionnaires before and after the lesson so we can measure changes in their knowledge, attitudes, and curiosity. The goal of this research is to determine whether using a graphic novel helps students develop a more accurate and lasting understanding of microorganisms at an earlier age.

PROCEDURES

Students will take part in the study during their regular class time. Some classrooms will be randomly assigned to learn about microorganisms through a graphic novel, while others will use a traditional presentation covering the same material. Before the lesson, students will complete a short, anonymous questionnaire about their attitudes and knowledge of microorganisms, which will take about 10 minutes. The lesson itself will take about 20 minutes and will either involve reading the graphic novel together as a class or participating in a presentation and discussion. Afterwards, students will complete another short questionnaire similar to the first one. No names will be collected, and questionnaires will not affect students' grades. The research process will take ~40 minutes, and the total session will be ~60 minutes with the activities afterwards.

RISKS & BENEFITS

There are no foreseeable risks to participating in this study. The study will be focusing on microbiology concepts and misconceptions which are not inherently distressing or disturbing. Participants who have had a negative experience with the subject matter are encouraged to remove themselves from the study, and parents or guardians are encouraged to opt their child out. All content will be preapproved by classroom teachers before delivery since they know their students the best. The responses collected in this study will have no information to suggest a participant's identity, and they will not be

used as an assessment tool for grades in their classrooms. The results may be used in publications and presentations that will benefit the learning community and the field of microbiology.

COSTS AND COMPENSATION

You will not receive any monetary benefits for being in this research study. After the questionnaire is finished, the research team will engage the class in a variety of hands-on microbiology activities to further the students' learning and engagement in the subject area. This is a benefit for students since they will be able to do something a bit more fun after the lesson. Letters of thanks will be distributed to students, teachers, and parents, and updates on the research will be periodically provided to classroom teachers upon request.

VOLUNTARY PARTICIPATION

Taking part in this research study is completely voluntary. You may choose to have your student not to take part and opt out of the study. If you decide your student will be in this study, you may choose to stop their participation at any time. If you decide you do not wish for your student to be in this study, or if you choose to stop their participation, your student won't be penalized or lose any benefits for which they otherwise qualify. The decision to participate cannot be changed once the questionnaire answers have been submitted. Given that student responses are anonymous, survey data cannot be withdrawn once submitted.

CONFIDENTIALITY

Records of participation in this research study will be kept confidential to the extent required by law. All responses will remain anonymous, and the data will be randomly assigned a generated number for analysis. These opt-out forms will be kept in a locked filing cabinet in a locked room on the TRU campus. The questionnaires that will be the primary source of data will have no information to suggest a participant's identity, other than their grade. Electronic and hard copies will be kept in a locked office on the TRU campus and disposed of through confidential waste streams after 5 years as well.

SOURCE OF FUNDING

Thompson Rivers University Undergraduate Research Experience Award Program (UREAP).

QUESTIONS

We encourage you to ask questions. If you have any questions about the study, please contact Dr. Cheeptham at ncheeptham@tru.ca : Phone 250-371-5891.

If you have any concerns or complaints about your student's rights as a research participant, please contact the Chair of the Research Ethics Board at Research and Graduate Studies, Email: TRU-REB@tru.ca ; Phone: 250-828-5000.

*If you do **not** wish for your child to participate in the study, please sign the form below and return it to the teacher. **If you do not sign and return this form, your child will be included in the study.***

PERMISSION DECISION

I have been notified about the research study will be implemented in my student's class and hereby **withdraw** my child from participating in data collection.

Are you choosing to **opt-out** of the microbiology graphic novel research study participation?

☐ Yes

NAME OF STUDENT:	First: _____	Last: _____
	_____	_____
NAME OF PARENT/GUARDIAN:	First: _____	Last: _____
	_____	_____
Signature: _____	Date: _____	
_____	_____	

Student Assent Form

Student Assent Form

From Gram Stains to Graphic Novels: Researching a New Way to Teach Microbiology

Researchers:

- Dr. Naowarat (Ann) Cheeptham
- Lauren Mark (Undergraduate Researcher)
- Keilin Gorman (Collaborator)

Why we're doing this study

We want to learn if reading a short graphic novel can help students understand microbes. You will get to learn some cool things about microbes and do a short activity afterwards!

What you'll do

If you choose to take part:

- You'll fill out a short questionnaire before and after the lesson (each takes about 10 minutes).
- You'll either read a short graphic novel or watch a presentation about microbes.
- The whole activity will take about 40–60 minutes during your regular class.

You won't need to put your name on anything, and it won't affect your grades.

Will this hurt or be risky?

No. You'll just be learning about microbes and sharing your thoughts. If you don't like any part of the activity, you can stop at any time or skip a question.

What are the benefits?

You'll get to learn about microbiology in a fun and creative way, and afterwards your class will do some hands-on science activities! Your answers will help teachers and researchers find better ways to teach science.

Do I have to take part?

No. Taking part is completely up to you!

If you don't want to, that's totally fine. Nothing bad will happen and you can still do the fun activities, we just won't collect your data. If you start and then decide you don't want to continue, you can stop at any time. Because you aren't writing your name on anything, you won't be able to withdraw from the study after you have already handed it in.

Will my answers be private?

Yes. Your name will not be written anywhere on the questionnaires. Only the researchers will see the answers, and they won't know which answers belong to you.

Questions?

You can ask your teacher or the researchers any questions you have at any time.

- Dr. Ann Cheeptham: ncheeptham@tru.ca
 - Lauren Mark: markl11@mytru.ca
 - Keilin Gorman: kgorman@student.ubc.ca
-

Your Choice

Please check one:

☐ **Yes, I want to take part in this study.**

☐ **No, I don't want to take part.**

Name: _____

Grade: _____

Signature: _____

Date: _____

Teacher's Name: _____

TO BE FILLED OUT BY PRIMARY INVESTIGATOR ONLY

My signature means that I acknowledge receiving this opt-out consent form from the participants' parents/guardians.

Signature: _____

Name: Prof. Naowarat Cheeptham (Ann)

Date: _____

Appendix D: Ethics Application and Approval

Ethics Application

Link to RISE submission PDF: [Rise Submission](#)

Note Need TRU account to access.

Link is used due to file size

Ethics Approval

**Thompson Rivers
University Research Ethics
Board**

Thompson Rivers University
805 TRU Way
Kamloops, BC V2C 0C8

**Certificate of Ethical
Approval for Harmonized
Minimal Risk Behavioural
Study**

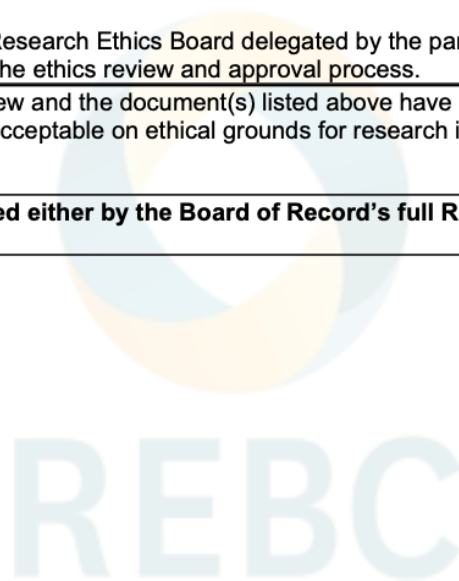
Also reviewed and approved by:

- UBC Behavioural Research Ethics Board



Principal Investigator: Naowarat Cheeptham	Primary Appointment: 	Board of Record REB Number: Board of Record: Thompson Rivers University Research Ethics Board	UBC REB Number: H25-03546
INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:			
Institution		Site	
UBC		Vancouver (excludes UBC Hospital)	
Non-UBC Institution		Site	
Thompson Rivers University		Main Campus - Kamloops	
Other locations where the research will be conducted: School District #73 School District #23 - Approval Pending			
Study Title: From Gram Stains to Graphic Novels: Researching a New Way to Teach Microbiology			
Study Approved: February 19, 2026		Expiry Date: February 19, 2027	
Research Team Members: Lauren Mark Keilin Gorman			
Sponsoring Agencies: - Thompson Rivers University			
Documents included in this approval:	Document Name	Version	Date
	Protocol:		
	Project Proposal	1	October 22, 2025
	Consent Forms:		
	Updated Consent Form	2	January 30, 2026
	Assent Forms:		
	Updated Assent Form	2	January 30, 2026
	Advertisements:		
	Outreach poster	1	October 22, 2025
Questionnaire, Questionnaire Cover Letter, Tests:			
Direct Instruction Post-Instruction Questionnaire	1	November 10, 2025	
Direct Instruction Pre-Instruction Questionnaire	1	November 10, 2025	

Graphic Novel Post-Instruction Questionnaire	1	November 10, 2025
Graphic Novel Pre-Instruction Questionnaire	1	November 10, 2025
<u>Other Documents:</u>		
TCPS2 Certificate - Ann	N/A	January 9, 2020
TCPS2 Certificate - Lauren	N/A	January 5, 2024
TCPS2 Certificate - Keilin	N/A	March 29, 2023
This ethics approval applies to research ethics issues only and does not include provision for any administrative approvals required from individual institutions before research activities can commence.		
The Board of Record (as noted above) has reviewed and approved this study in accordance with the most recent requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2).		
The "Board of Record" is the Research Ethics Board delegated by the participating REBs involved in a harmonized study to facilitate the ethics review and approval process.		
The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.		
This study has been approved either by the Board of Record's full REB or by an authorized delegated reviewer.		


 The logo for the Research Ethics Board of the City of Vancouver (REBC) is centered on the page. It features a stylized circular emblem composed of overlapping blue and yellow segments, with the letters "REBC" in a large, light blue, sans-serif font directly beneath it.

REBC