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[1] Institute of Biomedical Sciences, University of São Paulo (ICB, USP), São Paulo – São Paulo (SP) – Brazil. Graduate student, Department of Microbiology.

[2] Institute of Biomedical Sciences, University of São Paulo (ICB, USP), São Paulo – São Paulo (SP) – Brazil. Graduate student, Department of Microbiology.

[3] Institute of Biomedical Sciences, University of São Paulo (ICB, USP), São Paulo – São Paulo (SP) – Brazil. Undergraduate student, Department of Microbiology.

[4] Butantan Institute/ Institute of Biomedical Sciences, São Paulo – São Paulo (SP) – Brazil. scientific researcher, Department of Microbiology.

[5] Institute of Biomedical Sciences, University of São Paulo (ICB, USP), São Paulo – São Paulo (SP) – Brazil. faculty member, Department of Microbiology.

[6] Federal University of São Paulo (UNIFESP), Diadema – São Paulo (SP) – Brazil. faculty member, Department of Biological Sciences.

[7] Institute of Biomedical Sciences, University of São Paulo (ICB, USP), São Paulo – São Paulo (SP) – Brazil. faculty member, Department of Microbiology.

EDITORA IBERO-AMERICANA

FROM FACEBOOK® TO INSTAGRAM®: ADAPTING THE "ADOPT A BACTERIUM" PROJECT THROUGH THE LENS OF THE CONNECTIVISM LEARNING THEORY

DO FACEBOOK® AO INSTAGRAM®: ADAPTANDO O PROJETO "ADOTE UMA BACTÉRIA" SOB A PERSPECTIVA DA TEORIA DA APRENDIZAGEM CONECTIVISTA

DE FACEBOOK®A INSTAGRAM®: ADAPTANDO EL PROYECTO "ADOPTA UNA BACTERIA" DESDE LA PERSPECTIVA DE LA TEORÍA DEL APRENDIZAJE CONECTIVISTA

Bárbara R. C. ARMELLINI[1]
barbara.armellini@usp.br
Lara Nardi BARONI[2]
laranardibaroni@usp.br
Samantha C. Maia BRITO[3]
sammy.maiabrito@gmail.com
Ana Carolina R. MORENO[4]
carol@usp.br
Robson F.de SOUZA[5]
rfsouza@usp.br
Camilo LELLIS-SANTOS[6]
lellis.camilo@unifesp.br
Rita de C. Café FERREIRA[7]
ritacafe@usp.br

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ABSTRACT: Created in 2013, the “Adopt a Bacterium” project engages students in microbiology through social media, initially using Facebook® and later migrating to Instagram® as preferences shifted. This study examines the pedagogical impact of the transition among Biomedical Science undergraduates at the University of São Paulo enrolled in a bacteriology course. The project employed voluntary, anonymous questionnaires: before the course (Q1) to assess prior knowledge, immediately after (Q2) to measure learning, and five months later (Q3) to evaluate retention. Data were collected over three years and supported by a project evaluation survey. Analyses included thematic categorization, frequency tables generated with Pandas in IPython, and the Shannon Diversity Index to assess discourse richness. Results showed improved learning on Instagram®, with increased bacteriology terminology and higher Shannon Index values in Q2 and Q3. Findings indicate that “Adopt a Bacterium” remains effective across platforms, promoting active learning, student engagement, and microbiology education overall impact.

KEYWORDS: : Active learning. Adopt a Bacterium. Microbiology education. Virtual learning environments. Social media.

RESUMO: *Em 2013, o projeto “Adote uma Bactéria” foi criado para engajar estudantes em microbiologia por meio de postagens personalizadas no Facebook®. Com mudanças nas preferências de uso de redes sociais, migrou posteriormente para o Instagram®. Este estudo analisa o impacto pedagógico dessa transição entre estudantes de Ciências Biomédicas do ICB-USP matriculados em uma disciplina introdutória de bacteriologia. Como metodologia de aprendizagem ativa, aplicaram-se questionários voluntários e anônimos: antes da disciplina (Q1), após seu término (Q2) e cinco meses depois (Q3), para avaliar conhecimento prévio, adquirido e retido. Os dados coletados ao longo de três anos foram analisados por categorização temática, tabelas de frequência e pelo Índice de Diversidade de Shannon. Os resultados indicaram que o Instagram® promoveu maior aprendizado, evidenciado pelo uso ampliado de terminologia bacteriológica e por valores superiores do Índice de Shannon. Assim, o projeto mantém eficácia em diferentes plataformas digitais, fortalecendo a aprendizagem ativa em microbiologia atualmente.*

PALAVRAS-CHAVE: *Aprendizagem ativa. Adote uma Bactéria. Ensino de microbiologia. Ambientes virtuais de aprendizagem. Mídias sociais.*

RESUMEN: *En 2013, se creó el proyecto “Adopta una Bacteria” para involucrar a estudiantes en microbiología mediante publicaciones personalizadas en Facebook®. Con cambios en las preferencias de redes sociales, el proyecto migró a Instagram®. Este estudio analiza el impacto pedagógico de esa transición entre estudiantes de Ciencias Biomédicas del ICB-USP inscritos en un curso básico de bacteriología. Como metodología de aprendizaje activo, se aplicaron cuestionarios voluntarios y anónimos antes del curso (Q1), después (Q2) y cinco meses más tarde (Q3) para evaluar conocimientos previos, adquiridos y retenidos. Los datos recopilados fueron analizados mediante categorización, tablas de frecuencia y el Índice de Diversidad de Shannon. Los resultados mostraron mayor aprendizaje en Instagram®, evidenciado por el uso ampliado de terminología bacteriológica y valores superiores del Índice de Shannon en Q2 y Q3. Estos hallazgos indican que “Adopta una Bacteria” sigue siendo eficaz para promover aprendizaje activo y fortalecer la educación en microbiología.*

PALABRAS CLAVE: *Aprendizaje activo. Adopta una Bacteria. Educación en microbiologia. Entornos virtuales de aprendizaje. Redes Sociales.*

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INTRODUCTION

Traditional lecture-based teaching has long been criticized for its teacher-centered approach, in which knowledge is transmitted unidirectionally from teacher to student. In this model, students are typically positioned as passive recipients rather than active participants in their own learning processes. Numerous scholars have emphasized the need for student autonomy and active participation in knowledge construction (Freire, 1996). Foundational contributions by Jean Piaget et al. (1993) and David Ausubel (1963) also support this shift, suggesting that meaningful learning occurs when new information is connected to prior knowledge and the student plays a central, active role. In addition to classical constructivist theories, learning in digital environments is increasingly conceptualized through Connectivism (Goldie, 2016), which emphasizes the role of networked connections and the flow of information across digital platforms. Connectivism posits that learning occurs not solely within the individual but across networks of people, tools, and digital artifacts. This is particularly relevant for learning mediated by social media, where knowledge construction involves interaction with peers, algorithm-driven content, and multimodal resources. Furthermore, frameworks from Digital Pedagogy (Greenhow & Lewin, 2016) highlight the importance of understanding how formal and informal learning spaces intersect, raising questions about identity, agency, and the boundaries of academic engagement in online environments.

This pedagogical shift has spurred the development and implementation of active learning methodologies that prioritize student protagonism. These approaches are increasingly prevalent in both secondary and higher education, often integrating digital tools, particularly the Internet, given its pervasive presence in the lives of both students and educators. According to the United Nations Conference on Trade and Development (2017) and the Centro Regional de Estudos para o Desenvolvimento da Sociedade da Informação (2018), Brazil, along with India and China, accounts for approximately 70% of global Internet access, with nearly 70% of the Brazilian population connected to the Internet in some form.

Among digital tools, social media platforms have gained prominence as potential Virtual Learning Environments (VLEs). According to the digital report by We Are Social & Meltwater, We Are Social, which publishes DataReportal reports on internet and social media usage as well as other aspects of the digital world, in Brazil, around 60% of the population uses social media, and empirical studies have demonstrated the pedagogical value of these platforms in both secondary and higher education (Barroqueiro & Amaral, 2012; Botte et al., 2014).

One notable model that combines traditional and digital learning environments is Blended Learning, which seeks to create continuous and flexible learning experiences by merging in-person instruction with virtual interaction (Bonk & Graham, 2012; Bacich & Tanzi Neto, 2015). This model leverages digital culture features such as immediacy, hyperconnectivity,

and socio-digital engagement, while still retaining traditional teaching as a core component (Alammary et al., 2014; Morán, 2015).

In response to these educational transformations, the #Adopt Project was launched in 2013 with the initial implementation of "Adopt a Bacterium," which utilized Facebook® as an instructional tool for teaching microbiology. The platform was selected due to its widespread use among educators and students (Dunn, 2013), its potential to stimulate discussion and interaction (Santos & Campos, 2013), and its ability to strengthen teacher–student relationships (Souza & Andrade, 2016). However, as Instagram® gained popularity—now used by 14.4% of the global population and especially favored by individuals under 35—the project transitioned to this platform to better engage its target audience.

The project evolved into two main branches: "Adopt a Bacterium," focused on higher education (Piantola et al., 2018), and "Adopt a Microorganism," adapted for secondary education and particularly effective during the COVID-19 pandemic (Armellini et al., 2021). These initiatives provided relevant and engaging remote learning alternatives during a period of significant educational disruption (Longhurst et al., 2020; Noor & Husnine, 2020). They also fostered essential 21st-century skills such as "Learning to Learn" (Delors, 2000) and offered undergraduate and graduate mediators opportunities to develop valuable academic and professional competencies (Armellini et al., 2021).

Investigating the effectiveness of these initiatives in both remote and face-to-face contexts can offer valuable insights into their broader applicability and value in higher education. Therefore, this study aims to evaluate the impact of the "Adopt a Bacterium" project on student learning in higher education, with particular focus on its adaptation to Instagram® and its effectiveness across both online and in-person teaching formats.

MATERIAL AND METHODS

This study employed a qualitative-dominant mixed-methods research design, with the quantitative component serving a primarily descriptive purpose, without the use of inferential tests, aiming to characterize the data and enhance the interpretation of the results, and descriptive approaches to investigate student learning and knowledge retention through the "Adopt a Bacterium" project, implemented over three consecutive years (2020, 2021, and 2022). The first two editions were conducted entirely online due to the COVID-19 pandemic, while the 2022 edition took place in a traditional in-person teaching setting. Recruitment for the study began on August 5, 2020, and concluded on April 20, 2023. All participants provided written informed consent prior to data collection.

Project Design and Implementation

The "Adopt a Bacterium" project was integrated into the Bacteriology course for undergraduate students enrolled in the Biomedical Sciences and Fundamental Health Sciences programs. Each year, students were divided into small groups and assigned a bacterial species or genus to "adopt." The selection of bacteria varied annually based on course objectives, but the complexity and pedagogical demands remained consistent throughout all editions. In 2020, adopted bacteria included Corynebacterium diphtheriae, Mycobacterium tuberculosis, Neisseria sp., Streptococcus sp., Treponema pallidum, and Yersinia pestis. In 2021, the adopted bacteria were Escherichia coli, Mycobacterium tuberculosis, Streptococcus sp., Treponema pallidum, and Vibrio cholerae. In 2022, they included Mycobacterium tuberculosis, Escherichia coli, Staphylococcus sp., Streptococcus sp., and Pseudomonas sp

Throughout the course, students created posts on private social media accounts—Facebook® in 2020 and Instagram® in 2021 and 2022—linking the theoretical and practical course content to their adopted bacterium. Private accounts were used to allow for review and refinement of content before sharing with the broader community, thus minimizing potential misconceptions.

Students had the freedom to structure their posts as they saw fit, provided they addressed relevant scientific topics. These posts were reviewed, discussed, and enriched through the support of mediators (graduate and advanced undergraduate students) who guided the learning process.

At the conclusion of the posting period, each group prepared and delivered a seminar to share their findings with peers, leveraging the collaborative environment fostered by the shared posts. These presentations aimed to creatively and interactively disseminate the core biological and clinical characteristics of the adopted bacteria. Additionally, groups created outreach materials for broader public dissemination, further reinforcing their microbiological knowledge. Finally, a collaborative group exam, designed by the mediators, was administered to assess learning in an engaging and interactive manner. This evaluation included clinical case discussions, word search activities, and other interactive questions aligned with the #Adopt Project's pedagogical goals.

Data Collection Procedures

Three voluntary and anonymous questionnaires were administered to examine student knowledge throughout the project. Each questionnaire included a single open-ended question: "What do you know about the adopted bacterium?". The first questionnaire (Q1) was administered before the project to assess students' prior knowledge. The second questionnaire

(Q2) was administered at the end of the project, prior to the group exam, to gather insights into knowledge gained during the project. The third questionnaire (Q3) was administered five months after the project's conclusion to assess knowledge retention.

Thematic Analysis and Frequency Mapping

Student responses were thematically analyzed and categorized based on established microbiological content domains (Bardin, 1977). The categories included: none, morphology, genetics, pathogenicity, treatment, prevention, metabolism, ecology, taxonomy, reproduction, life cycle, examples, social impact, and others. Conceptual errors were also identified and categorized. Each response was coded for the presence or absence of these categories, followed by quantification of how frequently each theme appeared within individual answers.

The categorized data were compiled in Microsoft Excel®, and percentage frequency graphs were generated for Q1, Q2, and Q3. Additionally, frequencies of words related to key categories—morphology, pathogenicity, and metabolism—were tracked across the three questionnaires. These data were processed using the Pandas library in the IPython environment to construct frequency tables. Variations in word usage between questionnaires were visualized using Cytoscape, where nodes represented responses grouped by bacterial species, and node size reflected the frequency of theme-specific terminology. Decreases in thematic word usage were indicated by dotted edges.

Shannon Diversity Index Analysis

To further assess the diversity and depth of student responses, the Shannon Diversity Index (Shannon & Weaver, 1949) was calculated. Originally developed in ecology (Nguyen-Kim et al., 2014; Santini et al., 2017), this index has been adapted for microbiological (Liu et al., 2013; Rodrigues Hoffmann, 2014) and educational contexts (Armellini et al., 2021). It allows for systematic evaluation of the variety of content addressed in student responses and offers insights into patterns of knowledge distribution and acquisition. The formula used was:

$$H' = -\sum_{k=1}^{S} p_k \ln(p_k)$$

Where pk represents the relative frequency of each theme category in the responses, and S is the total number of unique content categories mentioned. The index was computed for both the entire student cohort and individually by group, using the frequency of theme citations as input data.

It is important to note that no formal inferential statistical tests (e.g., Wilcoxon or Kruskal–Wallis) were applied to compare Shannon Diversity Index values or thematic frequencies across the different time points. This decision reflects the primary orientation of the study toward qualitative inquiry, focusing on the descriptive characterization of students' discourse patterns and knowledge construction processes. The Shannon Index was employed as a heuristic tool to support the interpretation of discourse richness rather than as a variable for hypothesis-driven statistical testing. While quantitative elements complemented the analysis, the study was not designed to yield statistically generalizable results but rather to explore patterns of learning and engagement within the pedagogical context.

RESULTS

In 2020, there were 36 responses for Q1, 22 for Q2, and 20 for Q3. However, one response to the initial questionnaire was excluded from analysis because the student did not identify the bacterium adopted by their group and provided no meaningful information ("I know the morphology" was the response), making it impossible to analyze. In 2021, there were 44 responses for Q1, 28 for Q2, and 13 for Q3. In 2022, there were 36 responses for Q1, 39 for Q2, and 18 for Q3. That year, two responses from the Mycobacterium tuberculosis retention questionnaire were excluded for similar reasons, as they offered vague information that precluded analysis and categorization.

A general thematic analysis was initially conducted on the content addressed by students in their responses, categorized into thematic categories based on the core meanings (Shannon & Weaver, 1949). This analysis aimed to understand the general profile of microbiology content cited by students and track changes in citation patterns throughout the #Adopt project.

In 2020, responses to Q1 were generally shorter and more concise, with half (50%) addressing the pathogenicity of the adopted bacteria. Additionally, 36.1% of students reported having no prior knowledge about their assigned bacterium (Figure 1A). In 2021, most students (65.9%) reported knowing information related to pathogenicity, followed by 47.72% who mentioned morphology, and only 15.9% reported having no prior knowledge (Figure 1B). In 2022, a large portion (47.22%) stated they had some basic knowledge of pathogenicity, followed by 30.55% who claimed no prior knowledge (Figure 1C).

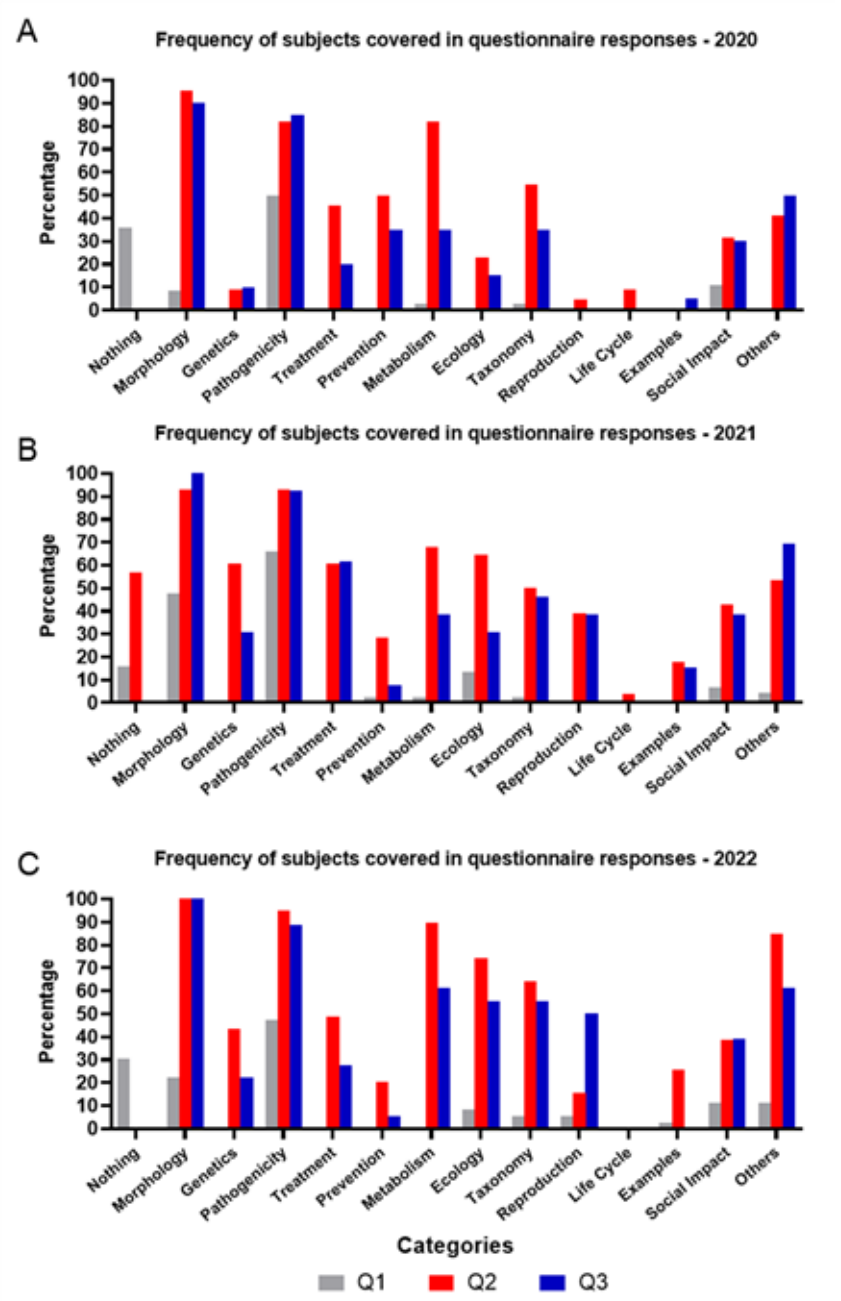
For the second questionnaire (Q2), in all years, student responses were notably longer and more elaborate, covering a wider range of aspects related to the adopted bacteria. In 2020, most students (95.45%) mentioned morphology or related themes, followed by pathogenicity and metabolism (81.81% for both) (Figure 1A). In 2021, the focus remained on

morphology and pathogenicity (Figure 1B). In 2022, all students (100%) discussed bacterial morphology, and most (94.87%) also addressed pathogenicity (Figure 1C).

For the retention questionnaire (Q3), responses were generally shorter and more direct compared to Q2 but still more elaborate than the initial Q1 responses. In 2020, most students (90%) mentioned morphological aspects, followed by pathogenicity (85%) (Figure 1A). In 2021, all students (100%) discussed morphology, while 92.3% mentioned pathogenicity (Figure 1B). In 2022, a similar pattern emerged, with all students (100%) citing morphology and 88.88% citing pathogenicity (Figure 1C).

Figure 1

Graphs showing the most frequently cited content in student responses in Biomedical Sciences and Fundamental Health Sciences courses



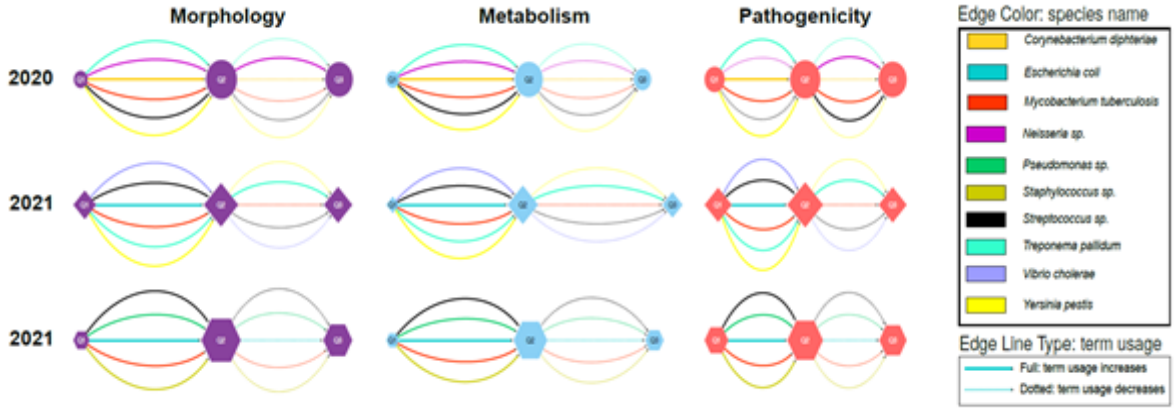
Note. Where [A] representing data from 2020 (Q1=36; Q2=20; Q3=22); [B] from 2021 (Q1=44; Q2=28; Q3=13); and [C] from 2022 (Q1=36; Q2=39; Q3=18). Q1 is represented in gray, Q2 in orange, and Q3 in blue. Prepared by the authors.

This thematic categorization was also performed individually for each student, enabling the calculation of the Shannon Diversity Index (Bardin, 1977).

Regarding thematic usage, variations were observed in the frequency of citations for the most discussed themes—morphology, metabolism, and pathogenicity—across the three questionnaires, as illustrated in Figure 2.

Figure 2

Graphs depicting the variation in terms related to morphology, metabolism and pathogenicity across the three questionnaires



Note. Where the terms related to morphology (purple), metabolism (blue), and pathogenicity (red) across the three questionnaires: Q1 (leftmost node), Q2 (middle node), and Q3 (rightmost node). Node size reflects the frequency of theme-related terminology. Prepared by the authors.

An increase in citation frequency was observed for all themes between Q1 and Q2, with Q2 consistently showing the largest node size. Between Q2 and Q3, there was generally a decrease in citations, especially for metabolism, leading to smaller node sizes. Nevertheless, citation frequencies in Q3 remained higher than in Q1.

The richness of student discourse was calculated using the Shannon Diversity Index (Shannon & Weaver, 1949) to assess how it evolved throughout the project stages and across student groups, providing insights into learning dynamics (Rodrigues Cintra Armellini et al., 2021).

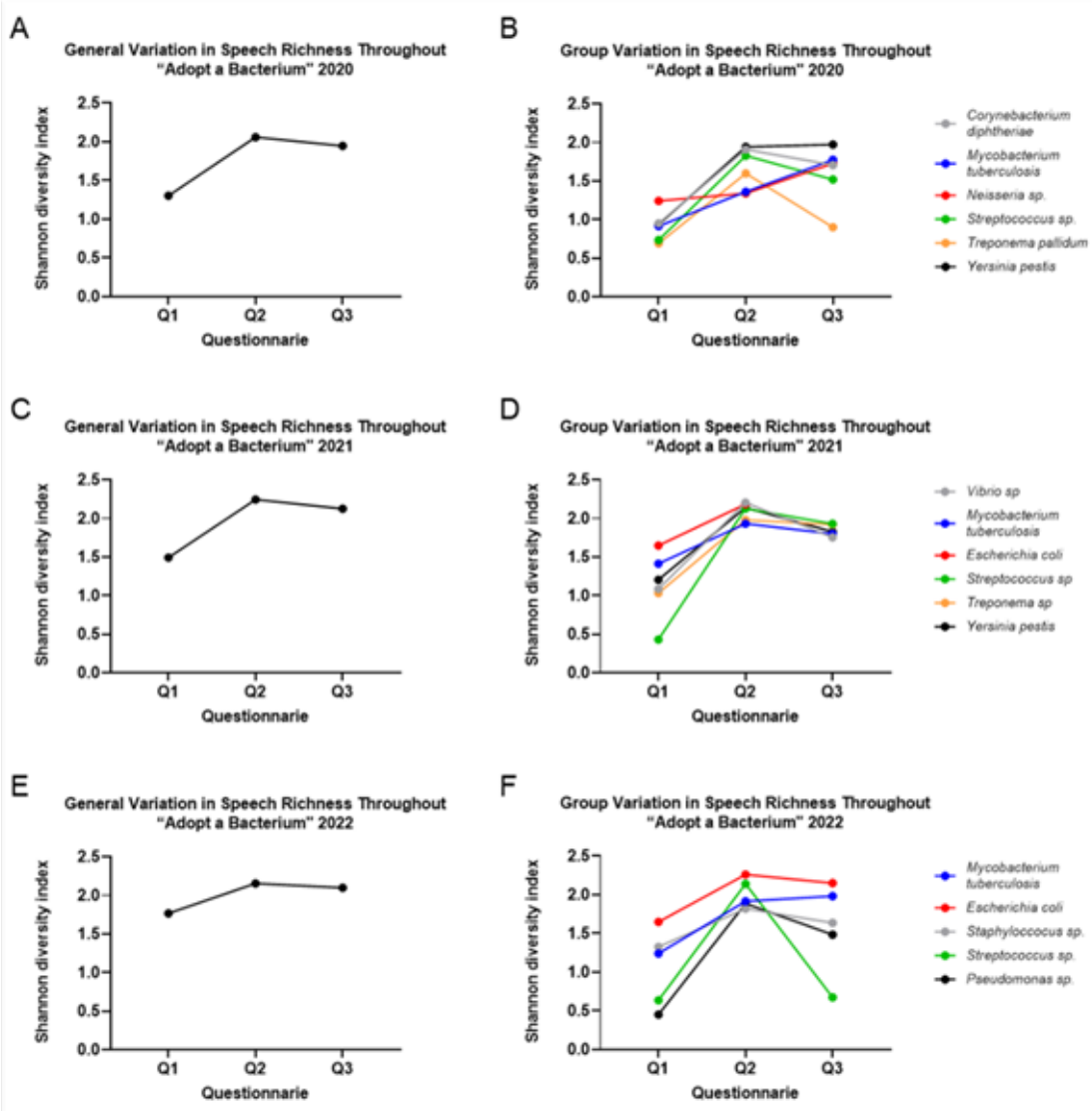
In the 2020 cohort, there was a clear increase in discourse richness in Q2 compared to Q1, with a slight decrease in Q3, although richness remained higher than in Q1 (Figure 3A). This trend was repeated for most groups; however, the Mycobacterium tuberculosis and Neisseria sp. groups exhibited higher richness in Q3 than in Q2 (Figure 3B). Conversely, the Treponema pallidum group showed a more pronounced decline in richness in Q3 compared to Q2, although it still surpassed the initial Q1 levels (Figure 3B).

In 2021, overall richness followed a pattern similar to 2020 (Figure 3C), with most groups also mirroring this trend. An exception was the Streptococcus sp. group, which showed an increase in richness in Q2 (Figure 3D) compared to other groups that year.

Finally, in 2022, the richness patterns generally resembled those of previous years, although the decline in richness from Q2 to Q3 was less pronounced (Figure 3E). This pattern was consistent across most groups, with exceptions: Mycobacterium tuberculosis showed an increase in richness in Q3 compared to Q2, while Streptococcus sp. showed a sharp decline in Q3 but was still higher than Q1 (Figure 3F).

Figure 3

Charts showing variation in the Shannon Diversity Index throughout the project questionnaires. Higher index values indicate greater discourse richness



Note: [A] Overall index for 2020 responses; [B] group-specific index for 2020; [C] overall index for 2021; [D] group-specific index for 2021; [E] overall index for 2022; [F] group-specific index for 2022. Prepared by the authors.

DISCUSSION

The findings of this study demonstrate that the "Adopt a Bacterium" project is an effective pedagogical strategy for teaching microbiology in both online and face-to-face formats. The methodology was associated with enhanced student learning, as evidenced by increased discourse richness, diversity of thematic content, and expansion of microbiological vocabulary. Moreover, the project's adaptability to different social media platforms, exemplified by the transition from Facebook® to Instagram®, highlights its flexibility in accommodating students' evolving digital behaviors while maintaining educational effectiveness.

The shift in platforms reflects broader changes in students' digital engagement, with younger generations increasingly favoring platforms where their peer networks are most active (McCay-Peet & Quan-Haase, 2017). Engagement and motivation tend to be higher when students are familiar with the chosen VLE (Solehudin & Darmayanti, 2018), making this transition crucial to sustaining the project's relevance and appeal. The similarity in discourse richness and thematic coverage across both platforms (Figures 1 and 2) indicates that this shift did not appear to compromise learning outcomes but rather adapted the content presentation to the unique features of each platform.

Consistent increases in discourse richness from Q1 to Q2 across all three years suggest effective concept acquisition during the project. While a decline in richness was observed in Q3, this decrease was expected given the five-month interval without formal reinforcement. Crucially, richness in Q3 remained higher than in Q1, indicating sustained knowledge retention despite the challenges of remote learning during the pandemic. These results align with stable patterns of thematic citation frequency across years, further affirming the project's robustness.

Variations in response rates, particularly the sharper declines observed in some bacterial groups during Q3, reflect common challenges in longitudinal educational studies, especially when follow-up occurs amid competing academic demands. These findings underscore the inherent difficulty of maintaining participant engagement over extended periods, a critical consideration for future iterations of the project.

The distinct characteristics of Facebook® and Instagram® also shaped student interactions, a key factor for learning and student development (Vygotsky, 1978). Facebook's text-centric environment encouraged longer, more elaborate posts, while Instagram's emphasis on visual content fostered creativity through images, drawings, and videos (Al-Bahrani & Patel, 2015). Despite these differences, there was no observable negative impact on learning outcomes, suggesting that pedagogical objectives can be achieved across varying communicative modalities. Such flexibility is vital in a landscape where student preferences for

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social media platforms evolve rapidly, requiring educators to adapt continually to maintain engagement.

However, it is important to acknowledge potential limitations and risks associated with using social media for educational purposes. Social media environments, including Instagram®, can contribute to digital dependency and cognitive overload, particularly when students are exposed to constant notifications, multimedia content, and peer interactions (Kuss & Griffiths, 2015). Such overload may hinder students' ability to focus on and retain academic content, especially when multitasking between academic and non-academic posts on the same platform.

Additionally, algorithmic content feeds on platforms like Instagram® prioritize user retention, which can redirect students toward unrelated entertainment and undermine educational objectives (Turel & Giles, 2011). Students may also become psychologically dependent on positive feedback, such as likes and comments, which can increase anxiety and shift focus from intrinsic learning goals to external validation (Andreassen et al., 2012). Furthermore, social comparison dynamics inherent in visually driven platforms can lower academic self-efficacy and participation (Vogel et al., 2014), particularly when visual appeal inadvertently overshadows content quality. Instagram® also blurs the lines between informal and formal learning spaces, making it harder for students to distinguish academic expectations from casual interactions (Greenhow & Lewin, 2016). Despite these concerns, students born after 2000 generally show greater engagement with methodologies that incorporate social media, as they are already familiar with these digital environments. Instagram®, in particular, allows them to share questions and knowledge more quickly and collaboratively (Joseph, 2025), aligning with the findings of this study.

These considerations underscore the importance of not only evaluating the pedagogical affordances of social media but also addressing the psychological and behavioral implications of using these platforms as VLEs. Future applications of the "Adopt a Bacterium" methodology should integrate strategies to mitigate these risks—such as establishing clearer content guidelines, monitoring platform engagement, and incorporating offline activities to balance screen time and encourage reflection.

Despite these challenges, the similar frequency of thematic citations on Facebook® and Instagram® reinforces that content comprehension was maintained across platforms. These findings challenge reliance on a single educational tool and emphasize the value of multimodal approaches that reflect contemporary communication diversity (Karlsen & Enjolras, 2016). By demonstrating the effectiveness of the #Adopt project across multiple platforms, this study provides evidence supporting the scalability and adaptability of social media–based pedagogies.

The context of remote teaching during the COVID-19 pandemic warrants special attention. Despite concerns about reduced student–teacher and peer interactions in virtual settings (Longhurst et al., 2020; Noor & Husnine, 2020), the #Adopt project maintained high levels of engagement and collaboration over all three years. This success likely stems from the project's inherently interactive design, which mandated group work throughout all stages, including assessments, thus fostering continuous peer and mediator interactions. Social media's interactive nature also facilitated communication and participation more effectively than some purpose-built educational platforms (Santos & Campos, 2013; Orr et al., 2009; Rabello, 2015; Brady et al., 2010), likely sustaining student motivation even during social isolation.

Collectively, these observations affirm that the "Adopt a Bacterium" project is a resilient, engaging, and effective active-learning methodology for microbiology education. It not only withstands the challenges of remote learning but also leverages social media's interactive potential to enrich student learning experiences.

Nevertheless, some methodological limitations should be acknowledged. The voluntary nature of questionnaire participation may introduce self-selection bias, potentially overrepresenting more motivated or engaged students. Future studies would benefit from random or mandatory participation to ensure broader representability. Variations in individual exposure to social media content may also create exposure bias, as not all students engage equally with the material; strategies such as standardizing posting frequency, monitoring platform engagement, and conducting in-class checks can help control for these disparities. Finally, incorporating a control group following traditional methods would strengthen the robustness of future comparative analyses. Another methodological limitation pertains to the absence of a formal inter-coder reliability assessment during thematic analysis for the current study. While coding was performed based on well-established categories and iterative discussions in our previous studies, the lack of ICR calculation constrains the ability to quantitatively verify the consistency of the qualitative coding process. Furthermore, the voluntary nature of the post-project retention questionnaire (Q3) likely led to participation from the most engaged or motivated students. This self-selection bias may overestimate knowledge retention and discourse richness at this stage.

While the project demonstrated effectiveness within the Brazilian higher education context, its transferability to different cultural and educational settings may require adaptation. Variations in students' digital habits, social media usage, and institutional support structures could influence the feasibility and impact of similar initiatives elsewhere. Further research is recommended to explore how this approach functions in diverse international contexts and across disciplines beyond microbiology.

The transition from Facebook® to Instagram® reflects not merely a platform change but an adaptive response to evolving student networks and preferred modes of information engagement. Connectivism emphasizes that in digital learning environments, knowledge is distributed across networks rather than residing solely within the learner (Siemens, 2004). This is evidenced by the students' collaborative knowledge construction, the use of multimedia affordances on Instagram, and the sustained discourse richness even after formal instruction (Q3). The iterative posting, peer feedback, and interaction with mediators align with connectivist principles that stress the importance of diverse, connected knowledge sources (Goldie, 2016). Furthermore, the observed retention of microbiological concepts over time supports the connectivist assertion that learning effectiveness is enhanced when learners can access and traverse dynamic information networks (Siemens, 2004; Downes, 2012). The students' engagement through Instagram exemplifies how networked learning operates; participants were not passive consumers but active contributors, constructing knowledge collaboratively within their peer groups and mediated interactions. The shift from Facebook® to Instagram® reflects the critical role of technology in shaping learning processes, as the affordances of visually driven platforms supported multimodal expression, instant feedback, and wide dissemination of information. This dynamic network of connections fostered not only content knowledge but also digital literacy and the ability to navigate complex information ecosystems. The adaptability of the "Adopt a Bacterium" methodology across different virtual ecosystems underscores that learning is less about static content delivery and more about fostering skills to navigate, filter, and contribute within knowledge networks, a key tenet of connectivism.

CONCLUDING REMARKS

Over the course of three years, spanning pre-pandemic, pandemic, and post-pandemic contexts, the #Adopt project consistently demonstrated its effectiveness in promoting student learning. The evidence includes increased discourse richness after project implementation, greater thematic diversity in student responses, minimal conceptual errors, and expanded microbiological vocabulary. The project successfully mitigated the negative educational impacts associated with the pandemic, as seen in the consistent learning patterns across years. Moreover, students' positive evaluations and strong performance outcomes indicate robust motivational and engagement benefits. Finally, the successful implementation of the project across various social media platforms highlights its versatility and potential for broader application in diverse educational contexts, provided that educators remain attentive to students' evolving digital habits and preferences.

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