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# Implementing a journal club as a teaching-learning strategy for plant genetics lectures during the COVID-19 pandemic

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Dr. Barry Fraser
Editor-in-Chief
Learning Environments Research

La Molina, 10th April 2023

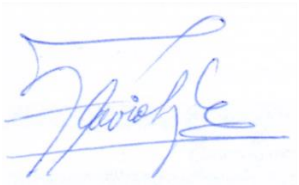
Dear Editor,

I hereby enclose the manuscript entitled “Implementing a journal club as a teaching-learning strategy for plant genetics lectures during the COVID-19 pandemic” by Flavio Lozano et al. to be considered for publication in *Learning Environments Research*.

The implementation of a learning-teaching methodology denominated “Journal Club” in plant genetics lectures was evaluated. The application of the methodology was developed during two academic semesters (i.e., one year) for five sections during the virtualization process due to the COVID-19 pandemic. There was an increase in both the critical thinking and writing skills of the participants. More than 80% of the participants were in favor of this “Journal Club” approach and considered it relevant to their professional education.

We think this manuscript is suitable for publication as the research reflects the aims and scope of your journal. The manuscript has not been published and is not under consideration for publication elsewhere. All authors have approved the manuscript and agree with its submission.

Yours sincerely,



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# Implementing a journal club as a teaching-learning strategy for plant genetics lectures during the COVID-19 pandemic

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## Author contributions

Flavio Lozano-Isla: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. Elizabeth Heros-Aguilar: Project administration, Validation, Writing – review & editing. Rember Pinedo-Taco: Conceptualization, Writing - review and editing, Resources. Andres Casas-Diaz: Supervision, Writing – review & editing.

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## Conflict of interest

Authors declares no conflicts of interest.

# Implementing a journal club as a teaching-learning strategy for plant genetics lectures during the COVID-19 pandemic


## Abstract

In crop science areas there are lectures where concepts are abstract. This generates a lack of interest in students due to the isolation between theoretical and practical concepts which limits critical thinking in students. Virtualization due to the COVID-19 pandemic aggravated this situation with the lack of practical classes due to the closure of laboratories and experimental fields in universities. There are different pedagogical strategies to increase the capabilities and interests of students. This paper presents the implementation of a journal club (JC) with the collaborative-metacognitive use of the scientific literature teaching approach (CMSLTA) as a strategy to reinforce theoretical-practical knowledge through the reading of scientific articles in an e-Lerning environment. The methodology was applied in two consecutive academic semesters in years 2021 and 2022 in the plant genetics lectures. The students read four articles per academic semester and performed an essay in groups. The results show that more than 80% of the participants agree with the JC implementation and they consider it relevant to their education. The application of the JC allowed the students to integrate knowledge covered in the theoretical lectures. Additionally, students presented improvements in skills within the framework of the seven Cs for critical thinking, teamwork, use of research tools, and an improvement in essay writing.


**Keywords:** CMSLTA, crop sciences, research tools, sci-hub, seven Cs, Zotero

## Introduction

The World Health Organization declared a pandemic on 11th March 2020, due to the SARS-CoV-2. This brought a new challenge for students and lecturers to implement remote distance learning worldwide (Daniel 2020; Harris et al. 2020). Platforms such as Zoom, Google Meet, and Microsoft Teams became the "new normal", and the primary venue for teaching and socializing.

A journal club (JC) is one of the well-established and popular graduate and post-graduate education methods with about 200 years of history (Topf et al. 2017). The JC was denominated in this way by Dr. James Paget in 1835. It was so named as the doctors of St. Bartholomew's Hospital, London, used to sit in a lounge and read the journals. But since their introduction by Sir William Osler in 1875 as regular meeting for a group of doctors and students to discuss publications where the JC have a long history in the medical sciences (Linzer 1987).

The original purpose of a JC was to help physicians stay up to date with current research and implement the research findings in clinical practice. It promotes group studying and contributes to developing a habit of continuously studying (Wenke et al. 2023). But many aims can be achieved by participants during JC sessions as spreading scientific information and knowledge transfer, keeping up to date with the literature, and developing critical thinking or analytical skills in general. The JC also acts as a motivating tool (Sanwatsarkar et al. 2022) and makes studying more manageable. Despite journal clubs being established as part of the medical education system (Ilic et al. 2020), studies that have investigated the effectiveness of journal clubs as a means of teaching evidence-based to plant science professionals are rare.

The present work was part of a pedagogical training course entitled "Designing my lecture" for professors starting their academic careers at the university. Each professor was encouraged to implement an improvement methodology in one of the lectures of his or her specialty. We describe and analyze the implementation of an e-Learning JC during two academic semesters for plant genetics lectures as collaborative-metacognitive use of science literature teaching approach (CMSLTA) at the Universidad Nacional Agraria La Molina, Peru. The central hypothesis was that the implementation of JC could improve the seven Cs in students and the capability to relate the topic of the lectures in an environment with a lack of practical knowledge due to COVID restrictions.

## Conceptual framing: e-Learning, Journal Club, CMSLTA, Seven Cs and pedagogy

### *e-Learning: online or distance learning*

e-learning is a term that refers to online or distance learning, which uses digital technologies to deliver education and training over the Internet (Clark and Mayer 2016; Mahdizadeh et al. 2008). Learning materials are delivered through an online learning platform and may include videos, readings, quizzes, discussion forums, and other interactive activities (Ganzert et al. 2017). Students can access learning materials from anywhere and at any time, giving them greater flexibility in their learning (Mayer 2003).

During the COVID-19 pandemic, many universities around the world adopted e-learning to continue online teaching and learning (Daniel 2020). The pandemic forced many educational institutions to temporarily close their campuses and look for alternatives to continue offering education to students (Mahdi 2023). e-learning became a popular option, as it allowed students to continue their education from home and remain safe during the pandemic. Many universities used online tools and platforms to offer live, recorded lectures, assignments, and assessments to students.

### *Journal Club*

A Journal Club is a group meeting where recent scientific articles are discussed. These meetings are common in academic and medical settings, but can also be held in other contexts, such as in a company or study group (Aweid et al. 2022; Golden 2023; Sanwatsarkar et al. 2022). Journal clubs have been widely used by clinicians for over a century to enhance critical appraisal skills (Ianno et al. 2020; Ilic et al. 2020; Linzer 1987).

The main objective of a Journal Club is to promote critical discussion and exchange of ideas about recent research in a given field. Participants read and analyze selected articles before the meeting, and then discuss their findings, methods, and conclusions. This helps keep participants up to date with the latest research and allows them to learn from others (Wenke et al. 2023). A Journal Club can also be an opportunity to improve critical and communication skills, as participants must explain and justify their views in a respectful and constructive environment.

In a university environment, a Journal Club can be an excellent way to encourage critical discussion and the exchange of ideas between students and professors. Students can have the opportunity to learn from professors and peers about the latest research in their field, and professors can take the opportunity to guide students in critically analyzing the literature (Golden 2023).

### *Collaborative-metacognitive use of science literature teaching approach (CMSLTA)*

The Collaborative-metacognitive use of science literature teaching approach (CMSLTA) is a pedagogical strategy that focuses on the use of collaborative and metacognitive scientific literature to enhance comprehension and critical thinking in science students (Daloos and Paderna 2023). The goal of the CMSLTA approach is to help students develop skills in reading, comprehending, analyzing, and evaluating scientific texts, as well as working in teams to discuss and solve complex problems in science (Hogan et al. 2015; Sandi- Urena et al. 2011). The CMSLTA strategy is based on

the idea that active and collaborative learning, as well as metacognitive reflection on the learning process itself, can enhance understanding of science and promote advanced cognitive skills.

The Journal Club could be considered CMSLTA. It refers to a teaching approach that engages students in the discussion and critical analysis of scientific literature, with a focus on the development of metacognitive skills, such as reflection and self-regulation.

In the context of the present implementation of JC, students work together to read and analyze scientific articles and discuss their findings, methods, and conclusions. This allows them to develop metacognitive skills by reflecting on their learning process and considering the perspective of others. In addition, working collaboratively in a Journal Club allows students to learn from their peers and teachers, and improve their communication and presentation skills. It also allows them to learn to work in teams and to develop leadership and problem-solving skills.

***Seven Cs***

The concept of the Seven Cs refers to a framework of twenty-first-century skills and is composed of seven key elements: communication, collaboration, creativity, critical thinking, cross-cultural understanding, computerized/information and communication technologies, and career/lifelong learning (Daloos and Paderna 2023). These elements are important for any type of communication, whether written or oral, and are especially useful in professional and academic environments. By following the principles of the Seven Cs, the quality of communication can be improved and the comprehension and effectiveness of the messages transmitted can be increased.

The implementation of a journal club could reinforce the following concepts:

1. Communication: The JC allows students to develop their communication skills by presenting their findings and discussing their ideas with their peers and professors.
2. Collaboration: By working together to analyze and discuss scientific literature, students can develop collaborative skills and learn to work as a team.
3. Critical thinking: By analyzing and discussing scientific literature, students can develop their ability to think outside the box and find creative solutions to scientific problems.
4. Criticism: By evaluating and discussing scientific literature, students can develop their critical thinking skills and evaluation of evidence.
5. Cross-cultural understanding: By learning about research in a global context, students can develop a deeper and more respectful understanding of different cultures and perspectives.
6. Computerized/information and communication technologies: By using technology to explore, read and discuss scientific literature, students can develop their digital skills.
7. Career/lifelong learning: JC is an active learning methodology that promotes keeping up-to-date with the literature and promotes self-learning allowing long-term learning.

### *Pedagogy*

University professors usually have specialized academic training in their field of study, however, they may lack the pedagogical skills to teach science. Many university professors have obtained additional training in pedagogy or have experience teaching science (Ganzert et al. 2017). Some university professors may not have formal pedagogical training and may have difficulty applying effective teaching techniques. In these cases, the university institution can provide training and support to help university professors develop pedagogical skills (Zohar and Schwartzer 2011). The pandemic highlighted an ongoing need for educational research on pedagogy (Singer et al. 2013), and how instructors may be able to most effectively shift teaching from face-to-face to remote teaching modalities (Barton 2020).

The Journal Club could be classified as an active and participatory pedagogical tool. In this type of teaching, students are responsible for their learning and actively participate in the discussion and analysis of scientific literature (Shah et al. 2022). The present implementation includes essay writing to promote conceptual learning, critical thinking, and communication skill (Dowd et al. 2018). In this context, JC could be considered a project-based pedagogical tool, as students are tasked with reading and analyzing scientific articles and then presenting and discussing their findings (i.e. essay). This project-based approach encourages problem-solving, collaboration, and creativity, and allows students to apply their knowledge to real situations.

## Methodology

### *Scope and Delimitations*

The Journal Club (JC) was implemented in the plant genetics lecture of the Agronomy faculty of the Universidad Nacional Agraria la Molina (UNALM), Lima, Peru. A total of 90 students between the sixth and seventh cycle of the agronomy course participated. The implementation took place during two academic semesters in the years 2021 and 2022. Each academic semester has a period of 16 weeks. The project was endorsed and approved by the UNALM. The students were informed of the project and the surveys were conducted voluntarily.

### *Teaching Approach*

The JC methodology was divided into four stages. The training stage was given only once per academic semester to all students. The following three steps (i.e. reading, writing, and discussion) were repeated for each article with a duration of 60 minutes per session (Figure 1). Although the oral language was Spanish, all the papers were read in English (Table 1). All lectures were conducted virtually through the Zoom platform.

Table 1: Reading list for the Journal Club (JC) implemented during two academic semesters in years 2021 and 2022 in the plant genetics lectures of the Agronomy Faculty at the Universidad Nacional Agraria La Molina (UNALM), Peru.

| JC | Semester | Title | Year | Journal | Type |
|---|---|---|---|---|---|
| 1 | 2021 | Breeding crops to feed 10 billion | 2019 | nature biotechnology | review article |
| 2 | 2021 | Imaged-based phenotyping accelerated QTL mapping and qtl × environment interaction analysis of testa colour in peanut (Arachis hypogaea) | 2021 | plant breeding | research article |
| 3 | 2021 | Genetic patterns offer clues to evolution of homosexuality | 2021 | nature | news |
| 4 | 2021 | Heritability in Morphological Robot Evolution | 2021 | arxiv | research article |
| 1 | 2022 | Genome-edited crops for improved food security of smallholder farmers | 2022 | nature genetics | review article |
| 2 | 2022 | Crucial factors for the feasibility of commercial hybrid breeding in food crops | 2022 | nature plants | review article |
| 3 | 2022 | Semiautomated Feature Extraction from RGB Images for Sorghum Panicle Architecture GWAS | 2019 | plant physiology | research article |
| 4 | 2022 | A chromosome predisposed for sex | 2022 | nature | news |

**Training (Research tools):** Students learn diverse tools that will enable the appropriate use of software and applications for reading articles and writing essays. Among these tools was Zotero in the desktop version as the web connector, Google Docs, Hypothesis, and web translators (i.e., Google Translate, DeepL, and DocTranslator). The training stage was in the first week of each semester and took 120 minutes.

**Week 1 (Reading articles):** Students were assigned into random groups of three to four. The groups and the randomization were made automatically in the Moodle system. At the begging of the lecture, the journal article was introduced and the students had 30 minutes to read it and extract all the essential information. At the end of the reading time, the main points in the article are discussed (i.e topic, research question, hypothesis, main results)

**Week 2 (Essay writing):** In the first 40 minutes the students in groups began to organize the writing of their essays. In the remaining 20 minutes, guidance on how to improve the essay writing or provided feedback on the essays from the previous JC was conducted.

**Week 3 (Reading discussion):** In the first 30 minutes, students were randomly grouped with members of other groups to discuss their ideas and views on reading. At the end of that period, all students were returned to the main room for the general discussion guided by the professor. In case there were no initial opinions, the professor asked questions and probed their reading to encourage further discussion by presenting different ideas and opinions. In some sessions, slides were used to present case studies or experiences about the reading topic to motivate the discussion. At the end of the session, the students have to submit their essays as the final product of JC.

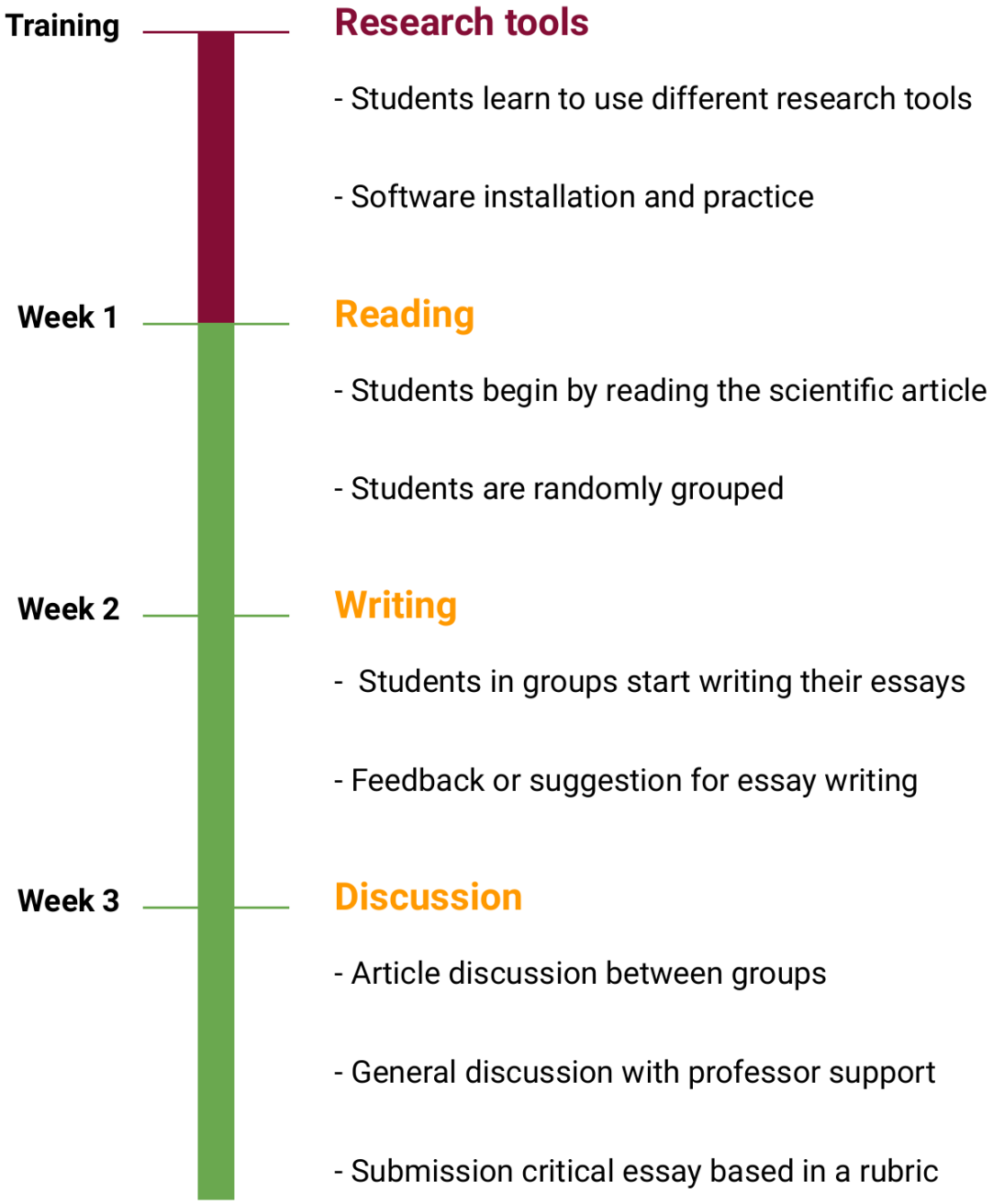


Fig. 1: Teaching approach of the Journal Club implementation in plant genetics lectures at the Agronomy Faculty at Universidad Agraria La Molina during two academic semesters in years 2021 and 2022. Training, the students learned different tools to read, write and discuss scientific documents. In week 1, the article was shared and the students began reading it. The students in groups start writing their essays in week 2, while in week 3, they discussed in random groups the assigned paper. Week 1 to 3 was repeated 4 times per academic semester.

### *Instrument*

**Survey design:** A survey was designed to determine the level of satisfaction with the JC implementation. In addition, objective questions were included to evaluate the tools that participants learned and used during the academic semester. The survey was voluntary and anonymous to allow students to express their opinion without any restrictions.

Table 2: Questions of the survey to evaluate the level of satisfaction of the Journal Club (JC) in the plant genetics lecture at the Agronomy Faculty of the Universidad Nacional Agraria La Molina during the period 2021 and 2022.

| Number | Question |
|---|---|
| 1 | Were the articles difficult to understand? |
| 2 | Was the time for each journal club adequate? |
| 3 | Should we read fewer articles? |
| 4 | Should we read more articles? |
| 5 | Was the number of articles appropriate? |
| 7 | Did you like the articles? |
| 8 | Do you consider the Journal Club relevant to your education? |
| 9 | Do you agree with its implementation? |

**Objective rubric:** Writing an essay was the final product of each journal club series (i.e., every three weeks). Grading was based on the use of an objective rubric (**Table S1,** Supplementary File 2). The grading system was from 0 to 20, where 20 is the highest grade. The names of the participants were removed from the grading book to maintain the privacy of the students (Supplementary File 3).

### *Data Collection and Analysis*

Data analysis was performed in the statistical software R version 4.2.2 (R Core Team, 2020). The scores were analyzed in a linear model taking into account the interaction of the factors: the journal club sessions, the section, and the semester of methodology implementation. The results were subjected to an analysis of variance to analyze the interaction between the factors. The estimated marginal means and the pair-wise comparisons test were performed with *emmeans* (Lenth et al. 2023) and *multcomp* (Hothorn et al. 2023) R package respectively. The graphs were made with the *inti* package (Lozano-Isla, 2022). Qualitative data analysis and graphs were analyzed by the frequency of occurrence of terms with the *wordcloud* package (Fellows 2018).

The reproducible analysis was performed under *Quarto* (Allaire et al. 2023) an open-source scientific and technical publishing system (Supplementary File 3).

## Results

### *Student perception*

An objective survey was designed to evaluate the students' perception of the journal club under synchronous e-Learning due COVID-19 pandemic. The survey was applied at the end of the semester at plant genetic lectures during two academic semesters in the years 2021 and 2022.

About 84.4% of the students agreed with the JC implementation and 83.3% considered it relevant to their education. Regarding the article read, 74.4% liked the articles chosen, whereas 84.4% indicated that the number of articles was adequate for the duration of the course. Additionally, 60% considered not reducing the number of articles, and 45% suggested increasing the number of articles to read. According to 87.8% of students, the timelapse for each JC was adequate. At least 14% of the student rated the chosen articles as difficult to understand, whereas 72.2% of students found their understanding medium to difficult (Fig. 2).

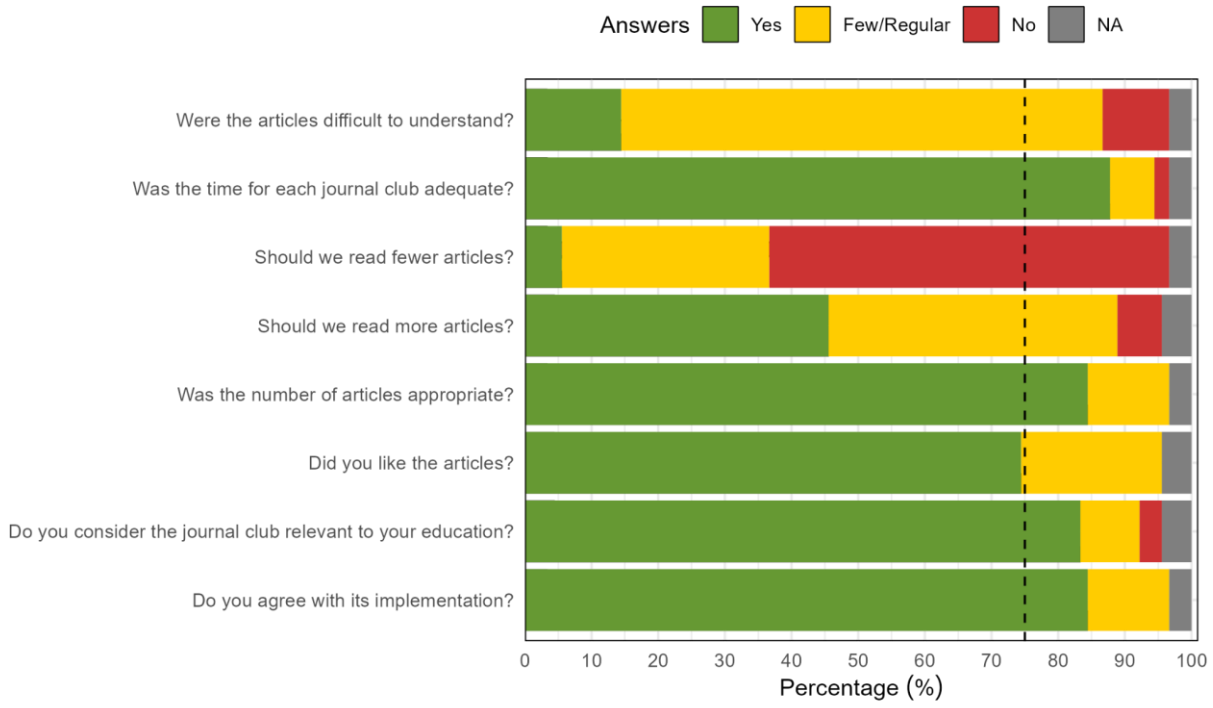


Fig. 2: Student perception on the application of the journal club teaching approach during two academic semesters in years 2021 and 2022 in the plant genetics lecture at the Universidad Nacional Agraria La Molina. The dashed line represents 75% of the participants and NA represents the questions not answered by the students. Results were based on a survey conducted on 90 students.

***Research tools and training***

The frequency with which each tool was used by the students was evaluated to determine the relevance of the training in the use of research tools during JC implementation

The frequency of the tools was divided into five groups represented by the colors: forest-green, blue, orange, purple, and gray (Fig. 3). The first group included Google Docs, Google Scholar, and Zotero with 11.9%, 10.7%, and 10.3%, respectively; while Sci-Hub and iLovePDF were in the second group with 9.3% and 9.1% respectively. The third group only included onlinedoctranslator with 5.6%. DeepL, Scimago Journal & Country Rank, and Foxit Reader were in the fourth group with 4.2%, 3.8%, and 3%, respectively. Tools such as Hypothesis, Articul8, and Grammarly represented less than 3% each.

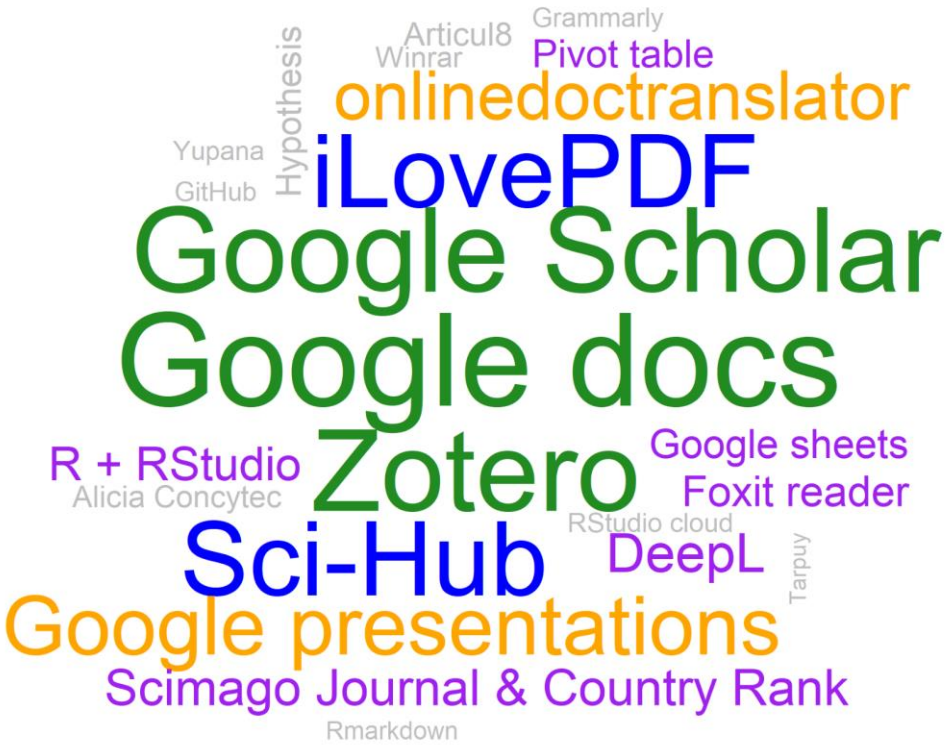


Fig. 3: Research tools learned and used by students during the implementation of the journal club in the plant genetics lecture during the period 2021 and 2022 at the Universidad Nacional Agraria La Molina. Results based on the frequency with which each tool was mentioned in 90 students surveyed.

***Progress in essay grades***

Essay by groups was the final product of each Journal Club. Essay grades after each journal club were compared among the five sections during two academic semesters in the plant genetics lecture.

Sections A and D presented an increase in the grades in time in both semesters. In the 2021-2 semester group A started with a score of 17.5 and at the end got a score of 18.4, whereas group D had 17 and 17.2, respectively, for the same

evaluations. In the 2022-1 semester group A started with 14.8 and ended with a score of 17.9, whereas group D had 16.5 and 18.6 gradings, respectively, for the same evaluations. For both sections, A and D showed a continued improvement in their grading over time during the two academic semesters (Fig. 4). Section D reduced their grading in 2021-1 for JC two and four and JC three in 2022-1 (Fig. 4). This reduction was associated with the type of articles (i.e., research articles, Table 1).

Section B in the 2022-1 semester did not show an improvement in the grading during the period of the JC. The initial grading for this group was 15.5 and ended with a grading of 15 (Fig. 4).

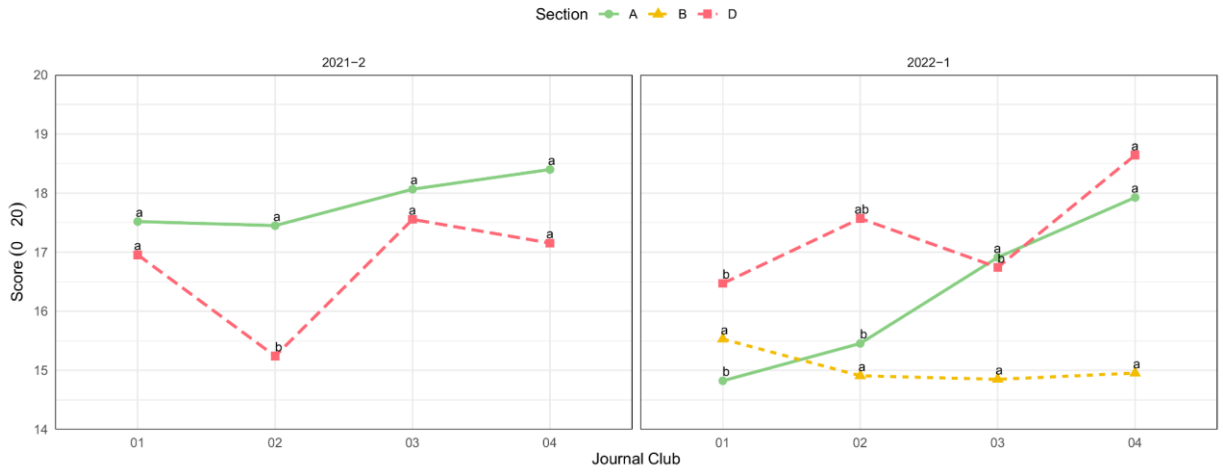


Fig. 4: Essays grading during the implementation of journal club during two academic semesters in years 2021 and 2022 for synchronous e-Learning at plant genetics lectures at the Universidad Nacional Agraria La Molina in five different sections. The grading system was from 0 to 20, where 20 is the highest grade. Results were based on the grading book from the five sections with a total of 90 students.

## Discussion

With the advent of the COVID-19 pandemic in 2020, there was a huge change in the development of lectures in the university worldwide (Barton 2020; Daniel 2020; Ozkara et al. 2022). Synchronous and asynchronous e-Learning became the main environment in which students interacted. Active learning classroom strategies need to be generated to engage the interest and motivation of students (Garcia-Vedrenne et al. 2020). We analyzed the implementation of a synchronous e-Lerniang journal club at plant genetics lectures. The results show that there is a positive perception of students towards the implementation of a journal club based on the application of a collaborative-metacognitive use of science literature teaching approach (CMSLTA).

For a long time, JC was used for teaching and knowledge sharing in medicine (Aweid et al. 2022; Ozkara et al. 2022), and in post-graduate education (Taverna et al. 2022). The JC approach was found to be educationally valuable, thus aiding in the development of critique skills, promoting research awareness, and professional empowerment, and generating a positive research culture and evidence-based practice (Xiong et al. 2018). The JC implementation received excellent feedback from participants. Our results reveal that 83% of the participants who participated in the implementation of the JC in the plant genetics lecture found it productive, and relevant to their formal education and they agreed with its implementation.

Meetings lasted ca.1 hour per week. An improvement in student interaction was achieved since the activities were in groups and open discussions with all the participants. Additionally, the students showed an improvement in their academic reading ability because the JC implies active learning (Ragland et al. 2023). Nevertheless, there was a reduction in grades when the students were exposed to reading and discussing research articles. However, there was an increase in the grading in four out of the five groups in the two evaluated academic semesters. Similar results were found by other authors during the JC sessions where the participants showed increased knowledge and critical thinking (Golden 2023; Ilic et al. 2020; Taverna et al. 2022).

In plant sciences lectures, field practices are an important component in the education of the students (Fleischner et al. 2017). Since the closure of the university campus due to COVID-19 and the quick transition to online courses, students were isolated from their respective universities with a negative impact on their education (McKim et al. 2021; Sahu 2020). Therefore, the JC is presented as a relevant alternative to an e-Learning approach to promoting the discussion and participation of students to strengthen the knowledge acquired in the theoretical lectures. In addition, the curricular structure of the lectures (i.e. syllabus) describes the themes presented in an isolated manner, which makes it difficult to understand the knowledge as a whole. The application of CMSLTA through the JC allows the students to read and discuss up-to-date literature and its application in a real context.

An advantage of implementing a journal club with essay writing is the reduction of cheating and plagiarism (Reynolds et al. 2020). As the use of articles allows for the diversification of readings in each semester. In most cases, the students benefit from the state of the art in the studied area and associate the theoretical knowledge that they are learning. The implementation of a JC at plant genetics helps to strengthen skills such as critical thinking, teamwork, independent learning, tolerance to different opinions, and digital skills included in the seven Cs framework.

The limitation of the present work was the design of the instrument for qualitative data collection. The instrument was based on survey research methods. The authors of this manuscript recognize the survey would have yielded more in-depth data. However, the choice was made to gather data as a preliminary, and timely, analysis of the JC implementation during the COVID-19 pandemic as an active learning strategy. Despite the limitations, we believe this study yields valuable insights.

The implementation of JC even after the post-COVID pandemic could be productive as some universities continue with a hybrid model for online teaching-learning because they provide a flexible and feasible platform for evidence-based e-Learning (Ozkara et al. 2022). Whilst from Educators' perspective support the idea that we should teach science as a means of acquiring knowledge, emphasizing the procedures of scientific inquiry rather than the mere memorization of facts (Moore 1984). The JC is an effective active pedagogical tool to promote project-based learning, which allows students to learn autonomously and apply their knowledge to real situations. The implementation of a JC promotes the development of skills contained in the Seven Cs and the critical analysis of scientific literature, with a focus on the development of metacognitive and collaborative skills.

## Conclusion

The implementation of a journal club in plant science lectures has presented an alternative that promoted the engagement of students with their learning and created a venue for academic discussions under the lack of field practice. The students perceive the JC as relevant to their formal education and they agree with its implementation. Additionally, the JC allows students to complement their theoretical knowledge and develop soft skills that are essential for success in the modern world and their lifelong learning.

## Data availability

The data and the reproducible analysis are available in Supplementary File 3.

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## Supplementary information

| | |
|---|---|
| **Title** | Implementing a journal club as a teaching-learning strategy for plant genetics lectures during the COVID-19 pandemic |
| **Journal** | Learning Environments Research |

## Supplementary Table 1

**Table S1:** Essay evaluation rubric for the journal club implemented in the plant genetics lectures.

| Criterios | Puntaje | Ausente | Regular | Bueno | Excelente | Descripción |
|---|---|---|---|---|---|---|
| **Puntualidad** | 0.0 | -5.0 | | | 0.0 | - Entrega de trabajos dentro del plazo asignado. |
| **Introducción** | 3.0 | 0.0 | 1.0 | 2.0 | 3.0 | - Introducción con los objetivos y/o hipótesis de la lectura (máximo 300 palabras).<br>- Texto escrito en un solo párrafo, separando los temas por punto seguido. |
| **Resumen** | 4.0 | 1.0 | 2.0 | 3.0 | 4.0 | - Resumen con los puntos más importantes señalados en el artículo. |
| **Discusiones** | 4.0 | 1.0 | 2.0 | 3.0 | 4.0 | - Crítica de la lectura, relacionándolo con los saberes previos, opiniones y temas tratados en clases.<br>- Incluir como mínimo una cita por cada integrante. |
| **Conclusiones** | 3.0 | 0.0 | 1.0 | 2.0 | 3.0 | - Escribir como texto corrido separadas por punto seguido respondiendo los objetivos (máximo 300 palabras). |
| **Referencias** | 2.0 | 0.0 | 1.0 | 1.5 | 2.0 | - Se recomienda usar Zotero para el manejo de referencias.<br>- La referencias deben estar completas: autor, título y año.<br>- NO colocar las citas y referencias toda escrita en mayúsculas. |
| **Formato** | 4.0 | 1.0 | 2.0 | 3.0 | 4.0 | > Formato:<br>- Usar el formato del American Psychological Association (APA).<br>- Fuente: Times New Roman<br>- Tamaño: 12<br>- Interlineado: 1.15<br>- Texto: justificado<br>- Páginas: máximo 4 páginas numeradas<br>> Recomendaciones:<br>- NO usar viñetas en el documento.<br>- Uso correcto de la gramática: nombres científicos, mayúsculas y signos de puntuación. |

**ENSAYO**

| | |
|---|---|
| **Título** | A chromosome predisposed for sex |
| **Autor** | Benavides Aceves, Alexandra Sofía<br>Curi Guzman William Ernesto.<br>Muñoz Huamani Lisbeth<br>Pino Ticona Paulo César |
| **Ensayo** | 4 |
| **Fecha** | 2022-07-26 |

## 1. INTRODUCCIÓN

Las células reproductoras masculinas y femeninas presentan semejanzas entre los animales, no obstante, la forma en la cual se establece el sexo es significativamente diferente y no es la misma en todos animales. Por ejemplo, dentro del reino animal encontramos especies como los peces payasos que presentan hermafroditismo secuencial pues pueden cambiar su sexo de macho a hembra, también estan animales como la lombriz que tienen hermafroditismo simultáneo y tiene la capacidad de alterar su sexo según no necesiten ya que cuentan con ambos sexos y además estan animales como los leones que son machos o hembras durante toda su vida. Debido a ello se tiene como objetivo comprender los mecanismos de la evolución en la determinación del sexo analizando el genoma del platelminto hermafrodita *Schmidtea mediterraneo*.

## 2. RESUMEN

Existen muchos conceptos donde se menciona que los espermatozoides y los óvulos comparten similitudes entre los animales, sin embargo, el mecanismo por la cual se determina el sexo es muy diferente. La diversidad de factores como la temperatura, demografia o por los cromosomas sexuales hace que la determinanción del sexo sea complicado de entender. Por ejemplo, algunos animales son hermafroditas produciendo óvulos y espermatozoides, otros animales presentan sexos separados y pasan toda su vida como hembras o machos. Los modelos teóricos mencionan que el gen que determina el desarrollo de los testículos surge primero de un cromosoma normal, luego se suprime la recombinación en la región cromosómica que lo rodea. A medida que evoluciona la supresión de la recombinación, el cromosoma Y se va aislando de X, generando que los cromosomas X e Y se vayan diferenciando entre sí. Además, la parte que no se recombina del cromosoma Y, denominado haplotipo, se hereda como una sola unidad de padre a hijo. Al estudiarse el genoma del platelminto hermafrodita *Schmidtea mediterraneo* se observó 2 haplotipos grandes, llamados J y V en diferente copias del cromosoma 1. Los haplotipos J y V forman la porción central de cada cromosoma y no se recombinan entre sí, al igual que los cromosomas X e Y, estos haplotipos de *S.*

*mediterránea* son geneticamentes distintos entre sí, diferenciándose tanto en la secuencia de ADN como en la expresión de muchos genes. Los haplotipos genéticamente divergentes que no se recombinan no suelen ser infrecuentes en los genomas, pero lo que es inusual en haplotipos de *S. mediterraneo* es que la región contiene muchos de los genes que subyacen al desarrollarse las gónadas masculinas y femeninas, por lo que se podría pensar que las mutaciones de estos genes producirian un haplotipo necesario para un sexo. Por lo tanto el organismo comenzará con la transición de ser hermafrodita a tener 2 sexos separados determinados por los cromosomas sexuales. Para *S. mediterraneo* los eventos que conducen a la evolución de los cromosomas sexuales empieza con la detención de la recombinación, seguida por la divergencia de los haplotipos. En la evolución de los cromosomas sexuales existen diferentes rutas evolutivas y ningún modelo único explica todas, pero haplotipos de *S. mediterraneo* nos ofrece un sistema importante para estudiar los genes implicados en la evolucion de la determinacion del sexo.

## 3. DISCUSIONES

La cepa sexual de *S. mediterraneo* es un hermafrodita simultáneo que desarrolla sistemas reproductivos tanto masculinos como femeninos en el mismo individuo adulto y se cruza obligatoriamente para fertilizar a otros individuos, por lo que es ideal para el estudio de la evolución cromosómica ya que podría proporcionar información sobre la evolución temprana de un cromosoma sexual primitivo (Zayas, 2005).

Las caracteristicas sexual se da a través de la diferencia entre los cromosomas X e Y determinan todas las características particulares del sexo masculino y femenino, diversos factores inducen a la diferenciación en mención incluida la expresión del gen Sry que causa la diferenciación de los testículos por ello este establece diferencias sexuales de por vida en los efectos de las hormonas de las gonadas (Arnold, 2017). Sin embargo, últimas investigaciones en cromosoma 1 podrían arrojar evidencias que se puede modificar el proceso de la determinación del sexo, lo cual podría inducir a diferenciación sexual dando como resultado individuos de un sexo lo cual significaria que no habria varias rutas de diferenciacion y factores que pueden influenciar el sexo de una especie.

Los resultados del estudio concluyeron que existe una vía alternativa para el surgimiento del haplotipo divergente del cromosoma sexual heterocigoto para el platelminto de la especie *Schmidtea mediterranea* mediante la supresión de la recombinación del par de cromosomas sexuales y la supresión del gen que determina uno de los 2 géneros para que solo se exprese uno de ellos. Estos resultados coinciden con lo expuesto por Guo (2022) que menciona que confirma la supresión de la recombinación con el siguiente enunciado: “el mapa de ligamiento revela una tasa extremadamente baja de recombinación en el cromosoma 1. Confirmamos la supresión de la recombinación en el cromosoma 1 mediante el genotipado de espermatozoides y ovocitos individuales.” y además confirma la existencia del mecanismo de supresión del gen determinante de uno de los géneros en el cromosoma divergente “Una mutación con

pérdida de función en el gen de uno de los dos cromosomas homólogos convertiría el cromosoma con la mutación en un cromosoma determinante masculino."

A pesar que estos mecanismo de evolución de cromosomas sexuales, se deben realizar estudios para identificar alelos respectivos a genes que pueden dterminar el sexo en una especie, también estos rasgos deben ser estudiados fenotipicamente contrarios dentro de la recombinacion genetica (Wright et al.2017).

## 4. CONCLUSIONES

El mecanismo que permite determinar el sexo es variado y complejo ya que no es universal entre los animales. Sin embargo, al analizarse al platelminto *Schmidtea mediterraneo,* que es un hermafrodita, se podría conocer más acerca de la evolución de la determinación del sexo mediante la observación de sus haplotipos. Se determino que esta especie tiene un mecanismo para la transición de ser hermafroditas a tener un sexo diferenciado a través de sus haplotipos ya que son distintos entre sí lo cual evita la recombinación y continua con la separación de estos, aunque aun falta conocer más acerca de otras vías evolutivas de diferenciación, nos da un un amplio panomara de los genes implicados en la evolución de la determinación del sexo.

## 5. REFERENCIAS

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## Table of contents



# Implementing a journal club as a teaching-learning strategy for plant genetics lectures during the COVID-19 pandemic

# 1 Setup

```
library(emmeans)
library(multcomp)
source('https://inkaverse.com/setup.r')

session_info()

─ Session info
─────────────────────────────────────────────────────────────────
 setting  value
 version  R version 4.2.3 (2023-03-15 ucrt)
 os       Windows 10 x64 (build 22621)
 system   x86_64, mingw32
 ui       RTerm
 language (EN)
 collate  Spanish_Latin America.utf8
 ctype    Spanish_Latin America.utf8
 tz       America/Bogota
 date     2023-04-10
 pandoc   2.19.2 @ C:/Program
Files/RStudio/resources/app/bin/quarto/bin/tools/ (via rmarkdown)

─ Packages
─────────────────────────────────────────────────────────────────
 package       * version  date (UTC) lib source
 agricolae       1.3-5    2021-06-06 [1] CRAN (R 4.2.3)
 AlgDesign       1.2.1    2022-05-25 [1] CRAN (R 4.2.0)
 askpass         1.1      2019-01-13 [1] CRAN (R 4.2.3)
 boot            1.3-28.1 2022-11-22 [2] CRAN (R 4.2.3)
 cachem          1.0.7    2023-02-24 [1] CRAN (R 4.2.3)
 callr           3.7.3    2022-11-02 [1] CRAN (R 4.2.3)
```

```
cellranger      1.1.0    2016-07-27 [1] CRAN (R 4.2.3)
cli             3.6.1    2023-03-23 [1] CRAN (R 4.2.3)
cluster         2.1.4    2022-08-22 [2] CRAN (R 4.2.3)
codetools       0.2-19   2023-02-01 [2] CRAN (R 4.2.3)
colorspace      2.1-0    2023-01-23 [1] CRAN (R 4.2.3)
combinat        0.0-8    2012-10-29 [1] CRAN (R 4.2.0)
cowplot       * 1.1.1    2020-12-30 [1] CRAN (R 4.2.3)
crayon          1.5.2    2022-09-29 [1] CRAN (R 4.2.3)
curl            5.0.0    2023-01-12 [1] CRAN (R 4.2.3)
devtools      * 2.4.5    2022-10-11 [1] CRAN (R 4.2.3)
digest          0.6.31   2022-12-11 [1] CRAN (R 4.2.3)
dplyr         * 1.1.1    2023-03-22 [1] CRAN (R 4.2.3)
DT              0.27     2023-01-17 [1] CRAN (R 4.2.3)
ellipsis        0.3.2    2021-04-29 [1] CRAN (R 4.2.3)
emmeans       * 1.8.5    2023-03-08 [1] CRAN (R 4.2.3)
estimability    1.4.1    2022-08-05 [1] CRAN (R 4.2.1)
evaluate        0.20     2023-01-17 [1] CRAN (R 4.2.3)
FactoMineR    * 2.8      2023-03-27 [1] CRAN (R 4.2.3)
fansi           1.0.4    2023-01-22 [1] CRAN (R 4.2.3)
fastmap         1.1.1    2023-02-24 [1] CRAN (R 4.2.3)
flashClust      1.01-2   2012-08-21 [1] CRAN (R 4.2.0)
forcats       * 1.0.0    2023-01-29 [1] CRAN (R 4.2.3)
fs              1.6.1    2023-02-06 [1] CRAN (R 4.2.3)
gargle          1.3.0    2023-01-30 [1] CRAN (R 4.2.3)
generics        0.1.3    2022-07-05 [1] CRAN (R 4.2.3)
ggplot2       * 3.4.2    2023-04-03 [1] CRAN (R 4.2.3)
ggrepel         0.9.3    2023-02-03 [1] CRAN (R 4.2.3)
glue            1.6.2    2022-02-24 [1] CRAN (R 4.2.3)
googledrive   * 2.1.0    2023-03-22 [1] CRAN (R 4.2.3)
googlesheets4 * 1.1.0    2023-03-23 [1] CRAN (R 4.2.3)
gsheet        * 0.4.5    2020-04-07 [1] CRAN (R 4.2.3)
gtable          0.3.3    2023-03-21 [1] CRAN (R 4.2.3)
haven           2.5.2    2023-02-28 [1] CRAN (R 4.2.3)
highr           0.10     2022-12-22 [1] CRAN (R 4.2.3)
hms             1.1.3    2023-03-21 [1] CRAN (R 4.2.3)
htmltools       0.5.5    2023-03-23 [1] CRAN (R 4.2.3)
htmlwidgets     1.6.2    2023-03-17 [1] CRAN (R 4.2.3)
httpuv          1.6.9    2023-02-14 [1] CRAN (R 4.2.3)
httr            1.4.5    2023-02-24 [1] CRAN (R 4.2.3)
huito         * 0.2.2    2023-01-24 [1] CRAN (R 4.2.3)
inti          * 0.6.0    2023-01-24 [1] CRAN (R 4.2.3)
jsonlite        1.8.4    2022-12-06 [1] CRAN (R 4.2.3)
klaR            1.7-2    2023-03-17 [1] CRAN (R 4.2.3)
knitr         * 1.42     2023-01-25 [1] CRAN (R 4.2.3)
labelled        2.10.0   2022-09-14 [1] CRAN (R 4.2.3)
later           1.3.0    2021-08-18 [1] CRAN (R 4.2.3)
lattice         0.20-45  2021-09-22 [2] CRAN (R 4.2.3)
leaps           3.1      2020-01-16 [1] CRAN (R 4.2.3)
lifecycle       1.0.3    2022-10-07 [1] CRAN (R 4.2.3)
lme4            1.1-32   2023-03-14 [1] CRAN (R 4.2.3)
lubridate     * 1.9.2    2023-02-10 [1] CRAN (R 4.2.3)
magick        * 2.7.4    2023-03-09 [1] CRAN (R 4.2.3)
magrittr        2.0.3    2022-03-30 [1] CRAN (R 4.2.3)
MASS          * 7.3-58.2 2023-01-23 [2] CRAN (R 4.2.3)
Matrix          1.5-3    2022-11-11 [2] CRAN (R 4.2.3)
memoise         2.0.1    2021-11-26 [1] CRAN (R 4.2.3)
mime            0.12     2021-09-28 [1] CRAN (R 4.2.0)
```

```
miniUI          0.1.1.1  2018-05-18 [1] CRAN (R 4.2.3)
minqa           1.2.5    2022-10-19 [1] CRAN (R 4.2.3)
mnormt          2.1.1    2022-09-26 [1] CRAN (R 4.2.1)
multcomp      * 1.4-23   2023-03-09 [1] CRAN (R 4.2.3)
multcompView    0.1-9    2023-04-09 [1] CRAN (R 4.2.3)
munsell         0.5.0    2018-06-12 [1] CRAN (R 4.2.3)
mvtnorm       * 1.1-3    2021-10-08 [1] CRAN (R 4.2.0)
nlme            3.1-162  2023-01-31 [2] CRAN (R 4.2.3)
nloptr          2.0.3    2022-05-26 [1] CRAN (R 4.2.3)
openssl         2.0.6    2023-03-09 [1] CRAN (R 4.2.3)
pillar          1.9.0    2023-03-22 [1] CRAN (R 4.2.3)
pkgbuild        1.4.0    2022-11-27 [1] CRAN (R 4.2.3)
pkgconfig       2.0.3    2019-09-22 [1] CRAN (R 4.2.3)
pkgload         1.3.2    2022-11-16 [1] CRAN (R 4.2.3)
prettyunits     1.1.1    2020-01-24 [1] CRAN (R 4.2.3)
processx        3.8.0    2022-10-26 [1] CRAN (R 4.2.3)
profvis         0.3.7    2020-11-02 [1] CRAN (R 4.2.3)
promises        1.2.0.1  2021-02-11 [1] CRAN (R 4.2.3)
ps              1.7.4    2023-04-02 [1] CRAN (R 4.2.3)
psych         * 2.3.3    2023-03-18 [1] CRAN (R 4.2.3)
purrr         * 1.0.1    2023-01-10 [1] CRAN (R 4.2.3)
questionr       0.7.8    2023-01-31 [1] CRAN (R 4.2.3)
R6              2.5.1    2021-08-19 [1] CRAN (R 4.2.3)
rappdirs        0.3.3    2021-01-31 [1] CRAN (R 4.2.3)
Rcpp            1.0.10   2023-01-22 [1] CRAN (R 4.2.3)
readr         * 2.1.4    2023-02-10 [1] CRAN (R 4.2.3)
remotes         2.4.2    2021-11-30 [1] CRAN (R 4.2.3)
rlang           1.1.0    2023-03-14 [1] CRAN (R 4.2.3)
rmarkdown       2.21     2023-03-26 [1] CRAN (R 4.2.3)
rstudioapi      0.14     2022-08-22 [1] CRAN (R 4.2.3)
sandwich        3.0-2    2022-06-15 [1] CRAN (R 4.2.3)
scales          1.2.1    2022-08-20 [1] CRAN (R 4.2.3)
scatterplot3d   0.3-43   2023-03-14 [1] CRAN (R 4.2.2)
sessioninfo     1.2.2    2021-12-06 [1] CRAN (R 4.2.3)
shiny         * 1.7.4    2022-12-15 [1] CRAN (R 4.2.3)
showtext        0.9-5    2022-02-09 [1] CRAN (R 4.2.3)
showtextdb      3.0      2020-06-04 [1] CRAN (R 4.2.3)
stringi         1.7.12   2023-01-11 [1] CRAN (R 4.2.2)
stringr       * 1.5.0    2022-12-02 [1] CRAN (R 4.2.3)
survival      * 3.5-3    2023-02-12 [2] CRAN (R 4.2.3)
sysfonts        0.8.8    2022-03-13 [1] CRAN (R 4.2.3)
TH.data       * 1.1-1    2022-04-26 [1] CRAN (R 4.2.3)
tibble        * 3.2.1    2023-03-20 [1] CRAN (R 4.2.3)
tidyr         * 1.3.0    2023-01-24 [1] CRAN (R 4.2.3)
tidyselect      1.2.0    2022-10-10 [1] CRAN (R 4.2.3)
tidyverse     * 2.0.0    2023-02-22 [1] CRAN (R 4.2.3)
timechange      0.2.0    2023-01-11 [1] CRAN (R 4.2.3)
tzdb            0.3.0    2022-03-28 [1] CRAN (R 4.2.3)
urlchecker      1.0.1    2021-11-30 [1] CRAN (R 4.2.3)
usethis       * 2.1.6    2022-05-25 [1] CRAN (R 4.2.3)
utf8            1.2.3    2023-01-31 [1] CRAN (R 4.2.3)
vctrs           0.6.1    2023-03-22 [1] CRAN (R 4.2.3)
withr           2.5.0    2022-03-03 [1] CRAN (R 4.2.3)
xfun            0.38     2023-03-24 [1] CRAN (R 4.2.3)
xtable          1.8-4    2019-04-21 [1] CRAN (R 4.2.3)
yaml            2.3.7    2023-01-23 [1] CRAN (R 4.2.3)
zoo             1.8-11   2022-09-17 [1] CRAN (R 4.2.3)
```

```
 [1] C:/Users/Maiz/AppData/Local/R/win-library/4.2
 [2] C:/Program Files/R/R-4.2.3/library
```

---

_

# 2 JC pipeline

```
library(magick)

pipeline <- image_read_pdf("files/pipeline.pdf") %>%
  image_crop("1350x1500")

pipeline %>%
  image_write(format = "pdf", "files/Fig1.pdf")

include_graphics("files/Fig1.pdf")
```

# 3 Import data

```
gsh1 <- "https://docs.google.com/spreadsheets/d/1yh44GeIx0mLttMmgFSuQ-
aNGLRO9yewaq8MWAclnznE/edit#gid=111798384"
# browseURL(gsh)
gs_score <- as_sheets_id(gsh1)

gsh2 <-
"https://docs.google.com/spreadsheets/d/1G2hvWcnEMCrrvR_J0_j2IBpAUELx1dAhTaOK
8eObBK8/edit#gid=1412841139"
# browseURL(gsh)
gs_survey <- as_sheets_id(gsh2)
```

# 4 Googlesheets connect to surveys

```
e21.2 <- gs_survey %>%
  range_read("S21-2") %>%
  select("Curso",  matches("Herramientas|artículos|club")) %>%
  rename_with(~gsub("Sobre los artículos"
                    , "Sobre el club de lectura (Journal Club)"
                    , x = .x)) %>%
  rename_with(~gsub("Herramientas que aprendí en el curso"
                    , "Herramientas que aprendí durante el curso"
                    , x = .x)) %>%
  rename_with(~gsub("Opinion, comentario y/o recomendaciones sobre los
artículos"
                    , "Opinión, comentario y/o recomendaciones para el club de
lectura (Journal Club)"
                    , x = .x)) %>%
  mutate(year = "2021-2", .before = Curso)
```

```
e22.1 <- gs_survey %>%
  range_read("S22-1") %>%
  select("Curso",  matches("Herramientas|artículos|club")) %>%
  rename_with(~gsub("Sobre los artículos"
                    , "Sobre el club de lectura (Journal Club)"
                    , x = .x)) %>%
  rename_with(~gsub("Herramientas que aprendí en el curso"
                    , "Herramientas que aprendí durante el curso"
                    , x = .x)) %>%
  rename_with(~gsub("Opinion, comentario y/o recomendaciones sobre los
artículos"
                    , "Opinión, comentario y/o recomendaciones para el club de
lectura (Journal Club)"
                    , x = .x)) %>%
    mutate(year = "2022-1", .before = Curso)

fb <- list(e21.2, e22.1) %>%
  bind_rows() %>%
  select(!contains("Sobre el curso [Herramientas usadas]")) %>%
  mutate(across(where(is.character), ~na_if(., "Aprendí a usar"))) %>%
  mutate(across(where(is.character), ~na_if(., "Aprendí a usar, Relevante
para mi formación"))) %>%
  relocate(contains("Opinión"), .after = last_col()) %>%
  dplyr::filter(grepl(pattern = "fito", x = Curso, ignore.case = T))

names(fb)
##  [1] "year"
##  [2] "Curso"
##  [3] "Herramientas que aprendí durante el curso"
##  [4] "Sobre el club de lectura (Journal Club) [Estas de acuerdo con su
implementación]"
##  [5] "Sobre el club de lectura (Journal Club) [Consideras relevantes para
tu formación]"
##  [6] "Sobre el club de lectura (Journal Club) [Te gustarón los artículos]"
##  [7] "Sobre el club de lectura (Journal Club) [El número de artículos fue
adecuado]"
##  [8] "Sobre el club de lectura (Journal Club) [Deberiamos leer más
artículos]"
##  [9] "Sobre el club de lectura (Journal Club) [Deberiamos leer menos
artículos]"
## [10] "Sobre el club de lectura (Journal Club) [Los artículos eran
difíciles de entender]"
## [11] "Sobre el club de lectura (Journal Club) [El tiempo para cada JC fue
adecuado]"
## [12] "Opinión, comentario y/o recomendaciones para el club de lectura
(Journal Club)"

fb %>%
  web_table()
```

# 5 Summary by question

```
lbl <- gs_score %>%
  range_read("survey") %>%
  select(Pregunta, Question) %>%
```

```
  mutate(across(Pregunta, ~gsub("\\¿|\\?", "", .))) %>%
  deframe()

qst <- fb %>%
  select(matches("Sobre")) %>%
  rownames_to_column() %>%
  pivot_longer(!rowname) %>%
  mutate(name = gsub(".*\\[(.*)\\]", "\\1", name)) %>%
  group_by(name, value) %>%
  summarise(n = n()) %>%
  mutate(per = n/90*100) %>%
  ungroup() %>%
  mutate(nval = case_when(
    value %in% "Si" ~ 1
    , value %in% "Poco/Regular" ~ 2
    , value %in% "No" ~ 3
    , TRUE ~ 4
  )) %>%
  mutate(nqs = case_when(
    name %in% "Estas de acuerdo con su implementación" ~ 1
    , name %in% "Consideras relevantes para tu formación" ~ 2
    , name %in% "Te gustarón los artículos" ~ 3
    , name %in% "El número de artículos fue adecuado" ~ 4
    , name %in% "Deberiamos leer más artículos" ~ 5
    , name %in% "Deberiamos leer menos artículos" ~ 6
    , name %in% "El tiempo para cada JC fue adecuado" ~ 7
    , name %in% "Los artículos eran difíciles de entender" ~ 8
    )) %>%
  arrange(nqs, nval) %>%
  mutate(value = factor(value, levels = unique(value))) %>%
  mutate(name = factor(name, levels = unique(name)))

qst %>% str()
## tibble [29 × 6] (S3: tbl_df/tbl/data.frame)
##  $ name : Factor w/ 8 levels "Estas de acuerdo con su implementación",..:
1 1 1 2 2 2 2 3 3 3 ...
##  $ value: Factor w/ 3 levels "Si","Poco/Regular",..: 1 2 NA 1 2 3 NA 1 2
NA ...
##  $ n    : int [1:29] 76 11 3 75 8 3 4 67 19 4 ...
##  $ per  : num [1:29] 84.44 12.22 3.33 83.33 8.89 ...
##  $ nval : num [1:29] 1 2 4 1 2 3 4 1 2 4 ...
##  $ nqs  : num [1:29] 1 1 1 2 2 2 2 3 3 3 ...

qst %>% web_table()


plot <- qst %>%
  plot_smr(x = "name"
           , y = "per"
           , group = "value"
           , ylimits = c(0, 101, 10)
           , xlab = ""
           , ylab = "Percentage ('%')"
           , glab = "Answers"
           , color = c("#669933", "#FFCC00", "#CC3333", "gray")
           , gtext = c("Yes", "Few/Regular", "No", "NA")
           ) +
```

```
  geom_bar(stat = "identity", position = position_stack(reverse = TRUE)) +
  scale_x_discrete(labels = lbl) +
  coord_flip() +
  geom_hline(yintercept = 75, color = "black", linewidth = 0.5,
linetype="dashed")

plot %>%
  ggsave2(filename = c("files/Fig2.pdf")
         , plot = ., width = 20, height = 12, units = "cm")

include_graphics("files/Fig2.pdf")
```

# 6 Tools use Wordcloud

```
library(wordcloud)

recode <- c("Google académico" = "Google Scholar"
            , "Tablas dinámicas" = "Pivot table")

text <- fb %>%
  rename(tools = "Herramientas que aprendí durante el curso") %>%
  select(tools) %>%
  separate_rows(tools, sep = ",") %>%
  mutate(across(everything(), ~ trimws(.))) %>%
  drop_na() %>%
  group_by(tools) %>%
  summarise(n = n()) %>%
  arrange(desc(n)) %>%
  mutate(freq = n/sum(n)*100) %>%
  mutate(tools = recode(tools, !!!recode))

set.seed(2)

pdf("files/Fig3.pdf", width = 20/2.5, height = 20/2.5)
wordcloud(words = text$tools
          , freq = text$freq
          , scale = c(5,0.5)
          , min.freq = 1
          , random.order = FALSE
          , colors = rev(c("forestgreen", "blue", "orange", "purple",
"gray"))
          )
graphics.off()

include_graphics("files/Fig3.pdf")
```

# 7 Googlesheets connect to scores

```
s21.2 <- gs_score %>%
  range_read("s21.2") %>%
  select(matches("correo|JC-")) %>%
  rename_with(~gsub("Dirección de correo"
                    , "user"
```

```
                  , x = .x)) %>%
  pivot_longer(!user, names_to = "jc", values_to = "score") %>%
  mutate(across(everything(), as.character)) %>%
  mutate(across(where(is.character), ~na_if(., "-"))) %>%
  mutate(section = gsub(".*\\_(.*).*\\(Real\\)", "\\1", jc), .after = user)
%>%
  mutate(across(c(user, jc), ~gsub("\\D", "", .x))) %>%
  mutate(across(score, as.numeric)) %>%
  drop_na(score) %>%
  mutate(year = "2021-2", .before = user)

s22.1 <- gs_score %>%
  range_read("s22.1") %>%
  select(matches("correo|JC-")) %>%
  rename_with(~gsub("Dirección de correo"
                  , "user"
                  , x = .x)) %>%
  pivot_longer(!user, names_to = "jc", values_to = "score") %>%
  mutate(across(everything(), as.character)) %>%
  mutate(across(where(is.character), ~na_if(., "-"))) %>%
  mutate(section = gsub(".*\\((.*)\\).*\\(Real\\)", "\\1", jc), .after =
user) %>%
  mutate(across(c(user, jc), ~gsub("\\D", "", .x))) %>%
  mutate(across(score, as.numeric)) %>%
  drop_na(score) %>%
  mutate(year = "2022-1", .before = user)

scores <- list(s21.2, s22.1) %>%
  bind_rows() %>%
  mutate(across(where(is.character), trimws))

scores$user %>%
  unique() %>%
  length()
## [1] 161

str(scores)
## tibble [632 × 5] (S3: tbl_df/tbl/data.frame)
##  $ year   : chr [1:632] "2021-2" "2021-2" "2021-2" "2021-2" ...
##  $ user   : chr [1:632] "20190001" "20190001" "20190001" "20190001" ...
##  $ section: chr [1:632] "A" "A" "A" "A" ...
##  $ jc     : chr [1:632] "01" "02" "03" "04" ...
##  $ score  : num [1:632] 13.5 18.5 20 16 20 18.5 18 17 14.5 19.5 ...

scores %>% web_table()


model <- scores %>%
  lm(score ~ jc*section*year, data = .)

anova(model)
## Analysis of Variance Table
##
## Response: score
##                  Df  Sum Sq Mean Sq F value                Pr(>F)
## jc                3  178.48  59.492 15.2370       0.0000000014230 ***
## section           2  406.40 203.201 52.0433 < 0.00000000000000022 ***
```

```
## year              1   26.47  26.469  6.7791             0.0094469 **
## jc:section        6   97.25  16.208  4.1513             0.0004236 ***
## jc:year           3   89.32  29.773  7.6254       0.0000518930383 ***
## section:year      1  151.85 151.850 38.8913       0.0000000008357 ***
## jc:section:year   3   63.20  21.067  5.3955             0.0011397 **
## Residuals       612 2389.53   3.904
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
mc <- emmeans(model, ~ jc | section | year) %>%
  cld(Letters = letters, reversed = T)
```

```
mc
## section = A, year = 2021-2:
##  jc emmean    SE  df lower.CL upper.CL .group
##  04   18.4 0.361 612     17.7     19.1  a
##  03   18.1 0.361 612     17.4     18.8  a
##  01   17.5 0.388 612     16.8     18.3  a
##  02   17.4 0.361 612     16.7     18.2  a
##
## section = B, year = 2021-2:
##  jc emmean    SE  df lower.CL upper.CL .group
##  04 nonEst    NA  NA       NA       NA
##  03 nonEst    NA  NA       NA       NA
##  02 nonEst    NA  NA       NA       NA
##  01 nonEst    NA  NA       NA       NA
##
## section = D, year = 2021-2:
##  jc emmean    SE  df lower.CL upper.CL .group
##  03   17.6 0.380 612     16.8     18.3  a
##  04   17.2 0.367 612     16.4     17.9  a
##  01   17.0 0.412 612     16.1     17.8  a
##  02   15.2 0.367 612     14.5     16.0   b
##
## section = A, year = 2022-1:
##  jc emmean    SE  df lower.CL upper.CL .group
##  04   17.9 0.339 612     17.3     18.6  a
##  03   16.9 0.339 612     16.2     17.6  a
##  02   15.5 0.339 612     14.8     16.1   b
##  01   14.8 0.339 612     14.2     15.5   b
##
## section = B, year = 2022-1:
##  jc emmean    SE  df lower.CL upper.CL .group
##  01   15.5 0.344 612     14.9     16.2  a
##  04   15.0 0.344 612     14.3     15.6  a
##  02   14.9 0.344 612     14.2     15.6  a
##  03   14.8 0.344 612     14.2     15.5  a
##
## section = D, year = 2022-1:
##  jc emmean    SE  df lower.CL upper.CL .group
##  04   18.6 0.334 612     18.0     19.3  a
##  02   17.6 0.334 612     16.9     18.2  ab
##  03   16.7 0.334 612     16.1     17.4   b
##  01   16.5 0.334 612     15.8     17.1   b
##
## Confidence level used: 0.95
## P value adjustment: tukey method for comparing a family of 4 estimates
```

```
## significance level used: alpha = 0.05
## NOTE: If two or more means share the same grouping symbol,
##       then we cannot show them to be different.
##       But we also did not show them to be the same.

plot <- mc %>%
  plot_smr(type = "line"
           , x = "jc"
           , y = "emmean"
           , group = "section"
           , ylimits = c(14, 20, 1)
           , ylab = "Score (0-20)"
           , xlab = "Journal Club"
           , glab = "Section"
           , sig = ".group"
           # , error = "ste"
           ) +
  facet_wrap(. ~ year, ncol = 2)

plot
```

```
plot %>%
  ggsave2(filename = "files/Fig4.pdf"
          , plot = ., width = 30, height = 12, units = "cm")

include_graphics("files/Fig4.pdf")
```

# 8 Image pdf to png

```
library(tiff)

pdf2tiff <- list.files("files/", pattern = "Fig.*pdf", full.names = T)

imgs <- 1:length(pdf2tiff) %>% map(\(x) {

  filename <- pdf2tiff[x] %>% gsub(".pdf", "\\1.png", .)

  pdf2tiff[x] %>%
    image_read_pdf() %>%
    image_write(format = "png", filename)

})
```