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Language learners' social media engagement, autonomy, and algorithmic awareness

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Abstract

Social media and streaming platforms offer rich opportunities for language learners to engage with foreign languages beyond the classroom. However, platform algorithms often prioritise English content, limiting the visibility of other languages. This study explores how learners can develop algorithmic awareness, the ability to understand and influence how algorithms filter and promote content, to reshape their digital environments for more multilingual and autonomous language learning. Using a design-based approach, we implemented a bridging activity in four university-level foreign language courses (three in Russian and one in Spanish), involving 26 students at the University of Aveiro, Portugal. Data sources included post-activity questionnaires, student ethnographic diaries, conceptual maps, and teacher notes. Findings show that learners following instruction developed five key strategies organizing their autonomous language learning environment: (1) identifying how algorithms function, (2) shifting focus to non-English content, (3) using subtitles as a comprehension tool, (4) following interest-driven content pathways, and (5) recognising the limits of language learning via social media. Through this process, students came to view algorithmic awareness as essential to understanding how linguistic content becomes visible and accessible online.

Keywords: learner autonomy, social media, algorithmic awareness, bridging activity, language learning

Introduction

Social media and streaming platforms have emerged as essential environments for language learners, offering plentiful opportunities for out-of-class exposure to target languages. Such informal and autonomous engagement often proves instrumental in learners' language development (Lee, 2023; Vazquez-Calvo et al., 2024). This reinforces classroom instruction with opportunities such as more consistent oral practice where traditional instruction feels lacking (Zhang & Lui, 2023), sometimes even determining the

success of the overall learning trajectory such as prompting higher degrees of willingness to communicate in an L2 (Lee & Drajati, 2019). Existing research underscores that students in the Portuguese context predominantly use English when navigating social media (Shafirova & Araújo e Sá, 2023a). However, the visibility of additional languages is frequently hindered by platform algorithms that prioritise English content (Nicholas & Bhatia, 2023). This algorithmic bias raises questions about how learners might systematically access language content or promote other languages within their digital routines.

Against this backdrop, algorithmic awareness—the ability to understand how platform algorithms rank, filter, and push content (Shin et al., 2022)—has become a pivotal yet understudied dimension of online language learning. Previous work has shown that social-media engagement can cultivate several other forms of awareness vital to language development: cultural awareness, or learners' capacity to notice, interpret, and compare culturally embedded practices, products, and perspectives in digital texts (Miller et al., 2019; Yeh & Mitrić, 2021); and socio-pragmatic awareness, the skill of recognising situational appropriateness and selecting language forms that fit interlocutors' social roles and expectations in computer-mediated interaction (Reinhardt & Ryu, 2013). Yet research rarely addresses how knowing the logic of recommendation systems might empower learners to curate more linguistically diverse feeds and, in turn, foster plurilingual practices. The omission is consequential: users of less-dominant languages can easily slip back into an English-only habitus when algorithms, optimized for engagement, systematically privilege high-visibility English content. We suggest that without explicit strategies for "training" these algorithms—by searching, following, and interacting in their target languages—learners risk losing meaningful exposure to the very linguistic ecologies they seek to join.

To address this need, our study explores how explicit attention to algorithmic awareness can foster learner autonomy, broadly defined as the ability to exercise informed choices and self-direction in language study (Benson, 2015). Within a plurilingual perspective—which views students as users of multiple languages and emphasises the dynamic interplay of their linguistic repertoires (Council of Europe, 2001, 2020; Kramsch, 2006)—we propose a bridging activity designed around students' everyday consumption of digital video content. Bridging activities serve to connect out-of-class experiences with in-class learning, validating authentic language use in the "digital wilds" and cultivating agency (Thorne & Reinhardt, 2008). While much of the existing literature centres on social media platforms emphasising interactive engagement, our design uniquely targets video-based media and streaming services, where learners often consume content passively rather than through active social interaction.

This paper adopts a design-based methodology (McKenney & Reeves, 2013) to investigate the implementation of a bridging activity in four university-level language courses (three Russian and one Spanish), involving a total of 26 participants at the University of Aveiro, Portugal. We focus on two complementary design components: (1) a guided auto-ethnographic diaries of students' media consumption, and (2) classroom-based tasks that promote reflection on the embeddedness of the algorithmic functions, language autonomy, and plurilingual awareness. Specifically, we aim to answer the following questions:

RQ1. What strategies do university language learners use to navigate, organize, and monitor their informal language practices across social media during the bridging activity?
RQ2. In what ways do learners reflect on their language learning processes, including the development of personal strategies within social media contexts?
RQ3. How do learners reflect on the interplay between their algorithmic awareness and language learning autonomy when engaging with social media platforms?

By integrating algorithmic awareness, plurilingual perspectives, and bridging activities, the study addresses a significant research gap: the need to understand how learners can intentionally reshape their digital environments to support multilingual exposure and autonomous language learning. In doing so, it contributes both practical pedagogical tools and empirical findings on the interplay between media consumption, algorithmic awareness, and learner autonomy.

Theoretical framework

Digital language learning today unfolds at the crossroads of two interlocking constructs: learner autonomy, long recognized as the engine of sustainable second-language development, and algorithmic awareness, an emergent form of critical digital literacy that conditions what learners can in fact become autonomous about. The discussion below first revisits autonomy through the lens of Reinders' Learning-Beyond-the-Classroom (LBC) model (2021). It then argues that, because contemporary learning environments are curated by opaque recommender systems, a pedagogy of autonomy must now be expanded to include the conceptual and strategic competencies captured by the notion of algorithmic awareness. Together these strands form the conceptual spine of the bridging activity described in the Methods section.

Language learner autonomy and learning beyond the classroom approach

Ever since Holec's (1981) seminal work, autonomy has been defined as the learner's capacity to take charge of their own learning. Benson (2016) refines that definition by insisting on informed decision-making at every stage of the learning process, including

diagnosing needs, setting goals, planning, using strategies, practicing, monitoring and self-assessing one's progress. Research consistently links such self-direction to enhanced motivation, smoother transitions from classroom-bound learning to real-world language use, and a greater likelihood that learners will continue engaging with additional languages after formal instruction ends (Borg & Al-Busaidi, 2012).

The Learning-Beyond-the-Classroom (LBC) model (Reinders, 2021) translates language learner autonomy principles into a practical cycle for teachers and learners. It begins by raising awareness of out-of-class opportunities and of the value of autonomous engagement; proceeds to preparation, where learners are equipped with strategies and resources; offers guided support while learners experiment in authentic contexts; and finally extends classroom work by feeding experiential insights back into formal instruction. Importantly, each phase invites learners to revisit the seven autonomy behavioral indicators identified by Reinders (2010)—needs analysis, goal-setting, planning, strategy deployment, practice, monitoring, and reflection—thus establishing an iterative loop between intentional action and metacognitive appraisal.

While the LBC literature has generated a wealth of task designs (Susantini et al., 2021; Yeh & Mitric, 2021; York, 2023), some studies tacitly assume that the learning environments into which students venture are given—open fields to be explored at will. Yet, as Benson (2021) reminds us, the "where" of learning is not a neutral backdrop; it actively shapes what can be perceived, attempted, and accomplished. On social-media platforms, that "where" is now computed by algorithms. We therefore ask what autonomy entails when content and language input itself is filtered, ranked, and personalized by code.

Algorithmic awareness

Algorithms—rule-based procedures that transform vast data streams into individualized rankings (Gillespie, 2014)—determine which social media content users receive (Droguel et al., 2022), including posts surface on Instagram, which clips auto-play on TikTok, and which subtitles Netflix pre-selects. Because these systems are proprietary and continuously optimized for engagement, their logics remain largely invisible to end-users (Dogruel et al., 2020). Empirical studies show that such recommenders systematically privilege high-visibility cultures and languages, especially English (Hallinan & Striphas, 2016; Prey, 2017). In multilingual Europe, language learners who open an ostensibly borderless platform therefore encounter a linguistically bounded stream—unless they know how to bend the algorithm in another direction, for which they need to develop algorithmic awareness.

Building on Shin et al. (2022), we conceive algorithmic awareness as a two-layered competence. First, it can be construed as a conceptual grasp that feeds, search results, and recommendations are algorithmically produced rather than organically representative.

Second, it is also a strategic capacity to manipulate the signals (search terms, follows, likes, watch-time) on which algorithms rely, so as to cultivate a personalized flow of the target language(s).

Research into user behavior online endorses this dual perspective. Burrell et al. (2019) demonstrate that individuals who intentionally adjust their digital traces can diversify their content, while an exploratory study on pre-service teachers by Shafirova & Araújo e Sá (2025) shows that algorithmic awareness can be helpful for developing a critical understanding of the use of multilingual content in the classroom. These findings indicate that algorithmic awareness is not a peripheral digital skill but a prerequisite for equitable plurilingual exposure.

When the curatorial layer of the Internet is taken seriously, autonomy instruction must move beyond teaching learners what to do out of class and begin to address how digital environments can be made to cooperate with those intentions. Table 1 therefore re-specifies each LBC phase in algorithmic terms: learners first explore the ranking criteria that govern their feeds; they then construct and monitor a multilingual online ecosystem by acting on those criteria; finally they reflect on how algorithmic levers interact with the seven autonomy behaviors. In short, algorithmic awareness becomes the mechanism through which learners actively organize (Benson, 2021) their own learning environments.

Table 1

Framework for developing learner autonomy through algorithmic awareness in social media environments

Phase	Steps	Autonomy focus	Algorithmic awareness focus	References
Exploring social media environments	1. Explore how algorithms of different social media platforms work. 2. Notice languages and cultural contexts that appear in the social media content.	Needs analysis	Noticing the algorithms	Based on Benson's *Learning Environments* (2021) and Dogruel et al. (2020), *Algorithmic awareness*
Constructing/ monitoring personal learning environments	3. Influence the algorithms to see how the suggestions of the platform change. 4. Identify and monitor the personal language learning strategies.	Goal-setting Planning Strategy use Monitoring	Changing the algorithms patterns	Based on Benson's *Learning Environments* (2021), Reinders' (2010, 2021) *LBC* concepts, and Dogruel et al. (2020), *Algorithmic awareness*
Reflecting on the learning process	5. Reflect on the opportunities for autonomous language learning on social media. 6. Reflect on developing personal strategies for language learning. 7. Reflect on the algorithmic awareness and its connection to their LBC.	Practice Self-assessment Meta-reflection	Reflecting on the algorithms' patterns	Based on Reinders' (2010, 2021) *LBC* concept, and Dogruel et al. (2020), *Algorithmic awareness*

In essence, autonomy empowers learners to set directions; algorithmic awareness equips them to keep digital gatekeepers from steering them off course. Embedding the latter within the former releases the full potential of LBC in an era when recommender systems mediate almost every out-of-class encounter with languages and cultures. This integrated lens—Algorithmically-Informed LBC—provides the theoretical bedrock for the bridging activity developed and evaluated in the remainder of the article.

Methods

This study employs a design-based research (DBR) methodology, which aims to tackle real-world challenges by developing, testing, and refining research-driven innovations within classroom settings (Anderson & Shattuck, 2012; McKenney & Reeves, 2014). Here we address the challenge of fostering language learner autonomy of plurilingual university students through social media use. Using DBR, we will design and evaluate a pedagogical activity that equips students to raise their autonomy beyond the classroom.

This methodology includes both the development of theoretical knowledge through inquiry and the creation of a practical tool. In our case, the practical component consists of an educational product, a structured table for recording media consumption, and a specifically tailored bridging activity Multilingualism and diversity in new media (Shafirova & Araújo e Sá, 2023b).

Pedagogical proposal: bridging activities framework

Our pedagogical design is rooted in the concept of the bridging activity, which seeks to link students' out-of-school experiences with their in-school activities, fostering an awareness of informal language use (Thorne & Reinhardt, 2008). Coming from the valorizing language learning in the digital wilds (Shafirova et al., 2020; Zhang & Vazquez-Calvo, 2023), bridging activities reflect students' interests and occasionally include student-created artefacts, enhancing student agency and acknowledging the value of learning that takes place outside the classroom (Reinhardt & Thorne, 2011; Thorne & Reinhardt, 2008).

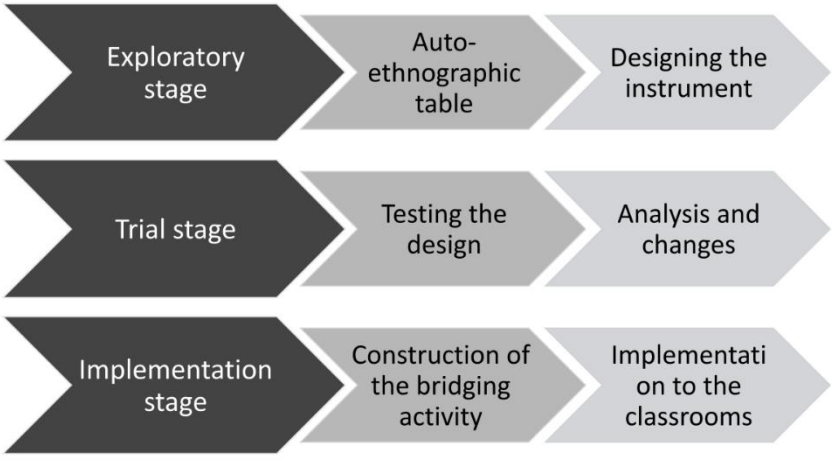
Our bridging activity is primarily based on auto-ethnographic observations, inspired by the learners-as-ethnographers approach. This method empowers learners to independently conduct research through observations or interviews, fostering their autonomy (Yeh & Mitric, 2021). In a recent study on online streamers on Twitch, auto-ethnographic observations were one of the main pedagogic recommendations for using online streaming videos in the language class curriculum (Akay & Ferronato, 2025). Following these recommendations, our auto-ethnographic observations are structured and serve as a scaffolding tool for students. The auto-ethnographic observation is structured as a table, allowing us to capture students' practices, which may be fragmented and spread across different platforms, schedules, and devices. Our goal here was to consolidate all observations into a single table, incorporating examples and images to support learners in their meta-reflective exercise. In the following section, we will discuss the design process of the bridging activity.

Design of the bridging activity

The design was constructed following DBR principles through a cycle of exploration and analysis (Figure 1).

Figure 1

Design of the bridging activity



The bridging activity was developed through three successive phases:

1. Exploratory phase (April – July 2022). An early version of the auto-ethnographic log was piloted with four volunteer undergraduates. Post-task interviews generated practical suggestions—clarifying prompts, adding visual examples—that were incorporated into a revised template.
2. Trial phase (November 2022 – January 2023). The first full prototype of the activity was embedded in the course of Linguistic and Cultural Diversity at Anonymous University. While students completed the tasks successfully, follow-up analysis (Shafirova & Araújo e Sá, 2025) revealed a missing element: structured peer discussion in which participants could compare insights and consolidate learning. This finding informed the final redesign.
3. Implementation phase (Spring 2023). The fully-refined bridging activity—now supplemented with guided small-group discussions—was rolled out across four language classes. The design and outcomes of this definitive implementation constitute the focus of the present article.

Instructional context and participants

The activity was implemented in four university language courses (3 Russian, 1 Spanish) with 26 participants in the Spring semester of 2023 at a level of the Bachelor degree of the

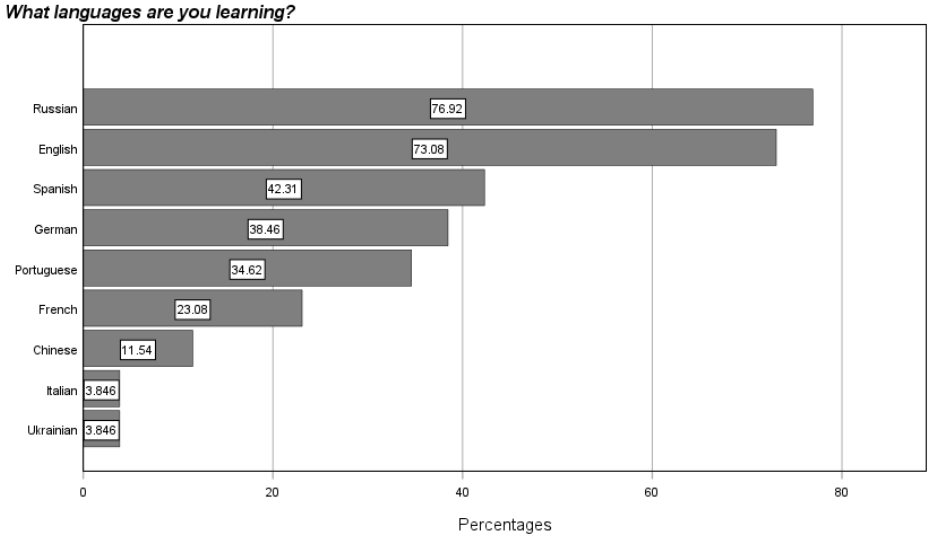
Language and Cultures faculty at the University of Aveiro (UA). The courses were from different levels: 1-Beginner (Russian); 2-Intermediate (Russian) and 3-Advanced (Russian and Spanish). The activity was extra-curricular and was implemented by the first author of the study.

Participants

A total of 26 students fully completed the post-activity questionnaire and are considered participants in this study. The students, aged between 18 and 25, and predominantly women (80%), were enrolled in one of two bachelor's programs offered by the faculty: Languages, Literatures, and Cultures or Languages and Business Relations. As part of their studies, they were required to choose three additional languages to learn, with options including English, Spanish, French, German, Russian, or Chinese (Figure 2). Some students learnt even more additional languages on their own including Italian and Ukrainian.

Figure 2

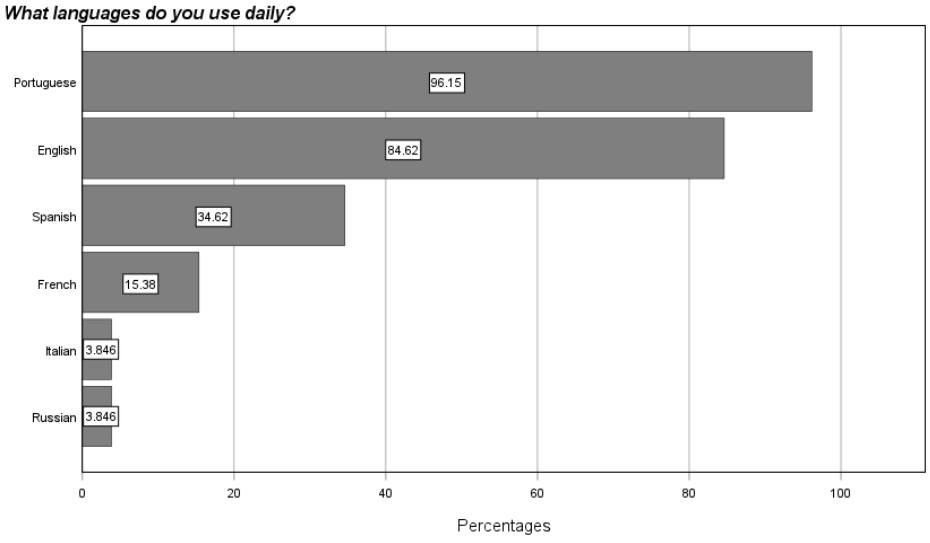
Students learning different target languages



Moreover, most of the students had Portuguese as their mother tongue. However, there were three exceptions: one Erasmus student from France (with French as a mother tongue), one from Italy (with Italian as mother tongue), and one student from Ukraine (with Ukrainian and Russian as mother tongues). When we asked the students about the languages they used daily, the most common responses were Portuguese, English, Spanish, and French (Figure 3). Some students also mentioned Italian and Russian, which corresponded to those whose mother tongue was the same.

Figure 3

Students using different languages on a daily basis



So, we can see that all participants in this study were learning several languages simultaneously, however in their daily use apart from Portuguese, English was the dominant language with the lack of other target languages except Spanish.

Data collection instruments

Data collection was carried out during the Spring semester of 2023. Four main instruments were implemented:

1. Auto-ethnographic diaries. For homework, each student had to complete a structured diary—a template with designated columns for timestamps, platform, language of the video, subtitle language, brief notes on content, and perceived learning outcome (Figure 4). Entries could be made in the language most convenient to the student (Portuguese, English, Russian, or Spanish).

Figure 4

Diary Example

Data	Tipo de video/Titulo(si hay)Plataforma	Tempo passado	Línguas e as suas variedades geográficas utilizadas oralmente	Línguas nas legendas (se houver, porque escolheu istos)	Línguas utilizadas nos comentários	Como compreendeu o vídeo (Leu as legendas? Ajudó o contexto visual? Algo mais?)	Aprendizagem linguística e cultural (vocabulário, costumes, história, tradições, alimentação, etc.)
18-04	Youtube	20:00	English and Russian	English	English and Russian	The Video had the sentences they were teaching written in en5	Vocabulary
18-04	Tiktok	00:30			English	The video itself was explanatory	Traditional dance

2. Conceptual maps. During the second classroom session, students worked in small groups to create visual "concept maps" that would prime them during plenary discussion (Ex., Figure 7). Each map captured the group's collective answers, expressed through drawings, key words, arrows, or short texts in any language they preferred, to three guiding prompts: How do algorithmic recommendation systems shape which languages become visible online? In what ways is watching video content in different languages or dialects beneficial? To what extent—and through which mechanisms—does video viewing support language learning?
3. Teacher field notes. After each lesson, the teacher-researcher recorded free-form field notes that documented: (a) the logistical flow and overall success of the session, (b) levels and patterns of student engagement, and (c) noteworthy aspects of group interaction and classroom dynamics. These brief, reflective entries provided an insider perspective on how the activity unfolded across classes.
4. Questionnaires. Immediately after completing the bridging activity, all participants were invited to fill in an anonymous online questionnaire. The 16-item instrument was drafted jointly by the project team and refined through expert review by two external applied-linguistics researchers, who checked content relevance and wording clarity. The final questionnaire comprised two sections. First, regarding background and participation (6 items), closed questions recorded age, degree programme, class level, target languages, and the extent to which each student engaged with the activity. Second, regarding perceptions of the activity (10 items), we considered the following items:
    1. Five Likert-scale statements (strongly disagree → strongly agree) probed the activity's perceived impact on (a) algorithmic awareness, (b) plurilingual awareness, and (c) self-directed learning. For example, (a) "This activity helped me to reflect on how algorithms work on social media and streaming platforms".
    2. One yes/no item asked whether the activity would help respondents learn additional languages, followed by an open text box for an explanation.
    3. One multiple-choice item identified which subtitle type (L1, L2, English, other, none) students found most useful, again followed by an open text box for justification.
    4. Two open-ended prompts invited comments on the activity's main strengths and weaknesses.

All questions were optional; no identifying information was collected, ensuring complete anonymity. Here is the overview of the collected data:

Table 2

Data corpus

Instruments	Data collected	Responds
Auto-ethnographic diaries	10 diaries, an average of 188 words per journal.	RQ1 and RQ2
Conceptual maps	10 maps	RQ3
Teacher notes	950 words	RQ1
Questionnaire	26 completed questionnaires	RQ3

Ethical note

The study follows the main ethical principles of the Portuguese data protection laws. We explained the objectives of the study and asked for the explicit consent of the students. The main participants were not obligated to take part in this study to pass the course.

Classroom implementation

The bridging activity was delivered by the first author in four university language courses, using an identical three-part sequence. This activity was not formally assessed by the teachers.

Part 1 – Introductory lesson (2h)

1. Orientation. The instructor outlined the project's goals: fostering learner autonomy beyond the classroom and cultivating algorithmic awareness.
2. Stimulus viewing. Students watched two short, multilingual videos that foregrounded linguistic and cultural diversity.
3. Diagnostic task. Working in small groups, students captured screenshots of their personalised social-media recommendations and noted the number and types of languages/dialects displayed; the dominant language(s); whether any content appeared in Spanish or Russian; possible reasons the algorithm served those items; and potential tactics for increasing target-language visibility.
4. Group reporting. Each group presented its findings, after which the instructor synthesised key points and assigned the auto-ethnographic diary as homework.

Part 2. Auto-ethnographic homework (3 days).

Using the structured diary (Figure 4), students recorded every video they watched, noting audio language, subtitle language, content type, platform, and perceived learning outcome. They were instructed to deliberately search for additional target-language content, "like" or otherwise engage with such content, and track whether subsequent platform recommendations became more multilingual. This homework was optional and not assessed by the teachers; therefore, the auto-ethnography was limited to three days, which was considered the minimum period in which observable results could emerge. Despite

this reduced duration, only 10 out of 26 participants (38%) completed the diaries. This limited participation has implications for the generalizability of the findings, making it difficult to transfer these implementations to other contexts.

Part 3 – Follow-up lesson (2h)

1. Reflection. Students compared diary entries in small groups, highlighting algorithmic shifts and learning gains.
2. Concept-mapping. Each group produced a visual map—using words, arrows, or sketches in any language—addressing how algorithms influence language visibility, the benefits of viewing videos in multiple languages/language varieties, and the contribution of video consumption to language learning.
3. Plenary synthesis. Groups presented their maps, prompting a whole-class discussion that linked personal experiences to the study's research questions on autonomy and algorithmic awareness.

Activities were conducted primarily in the respective target languages (Spanish or Russian), with Portuguese and English used strategically for clarification. This uniform implementation across courses ensured comparability while allowing each cohort to explore how algorithm-curated platforms shape their individual language-learning trajectories.

Analysis

A mixed-methods strategy was adopted, with each analytic phase aligned to a specific research question (RQ). Qualitative procedures followed Schreier (2012) systematic, content-analysis protocol; quantitative statistics were run in *SPSS* (v. 30). We organized our analysis following our research questions, while using different types of data sources responding to every question.

Phase 1: To address the RQ1 on how university language learners navigate and organize their informal language learning practices across social media we used both qualitative and quantitative analysis.

Qualitative component: A bottom-up content analysis (Schreier, 2012) was conducted on teacher fieldnotes and students' diaries with the unit of analysis as a diary entry. Emerging categories included five strategies: *algorithmic reconnaissance; refocus on other-than-English languages, subtitles as a comprehension tool, topic-driven "interest pathways", and awareness of the limitations of social media platforms*.

Quantitative component: A content analysis of 84 student-created video diary entries, processed using SPSS (v. 30) with the unit of analysis as a video description. Coded categories: *Video language, subtitle language, time of use, and self-reported learning outcomes.* This component added quantitative data illustrating some of the strategies

identified qualitatively, such as r*efocus on other-than-English languages, subtitles as a self-regulation tool, or topic-driven "interest pathways".*

Phase 2: To address the RQ2 on in what ways do learners reflect on their language learning processes we used qualitative analysis.

Qualitative component: A combination of bottom-down and -up content analysis (Schreier, 2012) was conducted on student's diaries and conceptual maps. We specifically looked for how students reflected on the already identified strategies in the first phase, however we also changed the categories depending on how students reflected on these strategies. The units of analysis consisted of students' final diary written reflections and multimodal references on the conceptual maps. Key categories included *algorithmic reconnaissance and comparison, valorising the cultural and linguistic diversity, subtitles as a learning tool, topic-driven "interest pathways" or content-creators as teachers, and lack of human interaction.*

Phase 3: To address the question of the learners' perceptions of their algorithmic awareness and language learning autonomy development (RQ3) we used both quantitative and qualitative analysis.

Quantitative component: Closed-ended questionnaire data analysed using *SPSS* (v. 30). This dataset provided overall statistics on the students' perceptions of their algorithmic awareness and language learning autonomy development.

Qualitative component: Open-ended questionnaire responses analysed via bottom-up content analysis. Emerging categories included *algorithmic awareness and linguistic diversity, language learning autonomy*, and *time management*. This dataset provided more details into the students' perceptions on the bridging activity.

All in all, this structured approach to data analysis with qualitative and quantitative methodologies combined helped us to give necessary insights to answer the RQs of this study. These insights will be related in detail in the next section.

Results

The diverse dataset allows us to follow learners from first contact with their social-media feeds through to personal reflection on what they had learned. The findings are organised around the three research questions (RQs). The first section addresses RQ1, examining five strategies students employed while navigating, organizing, and monitoring their informal language practices during the initial classroom exploration (Phase 1) and the construction of their auto-ethnographic diaries (Phase 2). The second section focuses on RQ2, analysing the conceptual maps that students created to reflect on the strategies previously identified. Finally, the third section addresses RQ3, presenting results from the post-activity questionnaire, which provides additional insights into students' perceptions and learning processes.

What strategies do university language learners use to navigate, organize and monitor their informal language practices? (RQ1)

Phase 1: initial classroom exploration

Phase 1 ("Explore") of the bridging activity asked students to audit their own feeds in order to (a) see how recommendation algorithms operate and (b) note which languages and cultural references their feeds actually deliver. The account below synthesizes the students' initial perceptions according to the teacher-researcher's observation diary written immediately after each of the four introductory classes.

The initial screenshot exercise, in which students discussed their social media feeds in groups, revealed that the feeds were almost entirely Anglophone, showcasing an English-heavy starting point. Teacher notes repeat the same finding in the Russian and Spanish classes: "The majority of the students watch everything in English" (TN_line_4). Only a handful of learners could point to clips in Spanish or Russian—their other study languages. Even so, students firmly endorsed online video as a language learning tool. They stressed its ability to (1) deepen cultural understanding of target-language communities; (2) provide contact with colloquial speech "watching videos helps to learn colloquial expressions and slang" (TN_line_18), and (3) sharpen pronunciation and expand vocabulary. However, one of the groups cautioned that "even though it is beneficial it could not substitute the interaction with people" (TN_line_55).

During the exercise focused on discussing students' social media feeds, they worked in groups to explore how algorithms might influence their content. This activity helped develop students' awareness of the first strategy of navigating their social media learning environments.

Strategy 1. algorithmic reconnaissance

Students remarked that, within English, algorithmic choice skewed toward *"mostly U.S. English"* (TN_line_5), a reminder that commercial popularity influences what surfaces first. While dissecting their home-feeds, every group identified three concrete tactics which could prompt platform recommendations, and therefore bend algorithmic performance for target languages appearance. Across all four groups, learners independently named the same three tactics (Table 3).

Table 3

Different tactics for changing algorithmic recommendations

Tactic	What students said	Purpose
Search language	Enter queries in the target language (TL)	Seed fresh TL content
Likes / follows	Actively like or follow TL videos and creators	Tell the system what you want
Watch-time/comments	Watch to the end; comment	Boost a clip's weight in the algorithm

We can see that all three tactics align with the theoretical understanding of how algorithmic recommendations are generated on social media (Shin et al., 2022).

Phase 2: auto-ethnographic diaries' construction

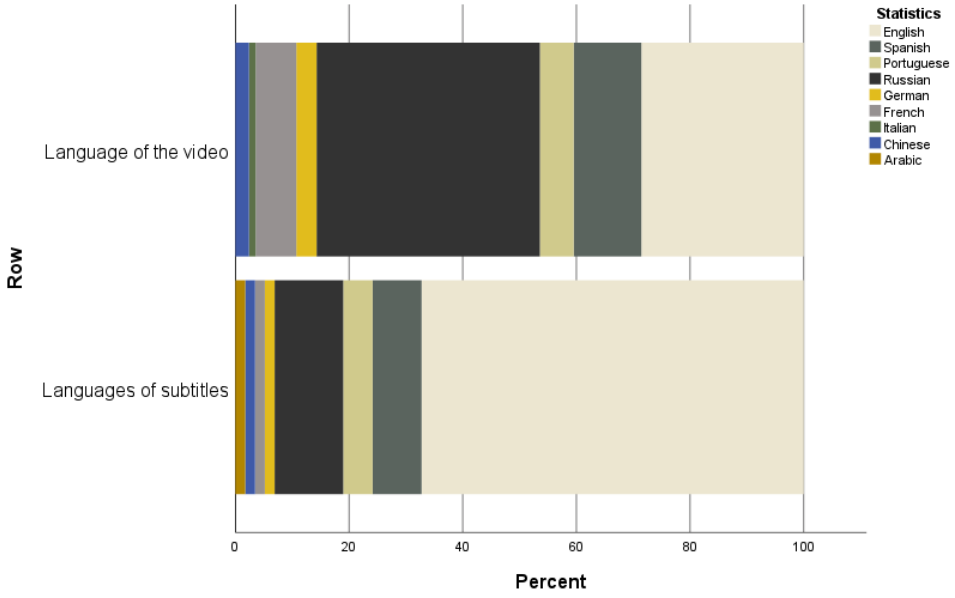
The second phase ("Construct") of the bridging activity prompted students to construct and monitor their social media learning environments by filling in the auto-ethnographic diaries. In doing so, students searched for videos in their target languages, developed personal comprehension strategies, and identified potential learning outcomes from exposure to diverse types of content.

Strategy 2. refocus on other-than-English languages

Over the next three days students actively applied those tactics when writing their ethnographic diaries. Nine languages surfaced in their diaries—Russian and Spanish (targets) plus German, French, Italian, Chinese, English and Portuguese—showing that they had begun to remix their feeds (see Figure 5). The diary protocol therefore confirms that learners can and do reorganize their informal "learning environment" once the task is made explicit.

Figure 5

Languages of the videos and the subtitles



The introductory lesson succeeded in changing the focus of the students to other-than-English languages. In the end of the diaries, some learners recognized that their feeds mirror their past language choices—and that small, deliberate actions could bring other languages into view. This shift in perspective marks the first step in this algorithmically-informed LBC pathway: treating social platforms as adaptable learning environments rather than passive streams of content.

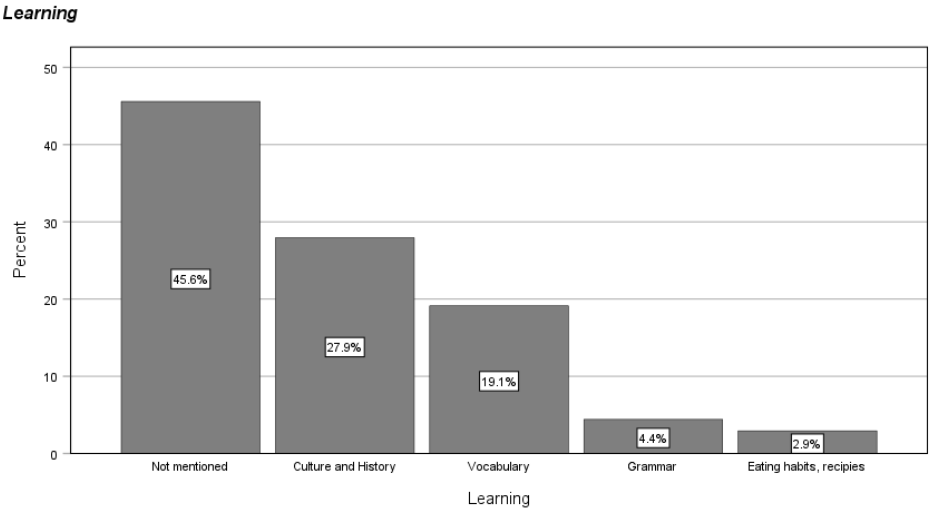
Strategy 3. social media as an environment for learning: topic-driven "interest pathways"

The use of social media as a learning environment was emphasized throughout the entire bridging activity. It was first discussed during the initial class and later incorporated into the design of the student diaries, which included a specific section for 'learning outcomes.' Additionally, some students went beyond the provided sections and described their own strategies for organizing language learning.

All students wrote different types of learning outcomes from the videos watched. In Figure 6, we can see that in around half of the entrances to the diary, the students were able to write some specific learning outcomes, with categories of *Culture and History* and *Vocabulary* being the most prominent learning outcomes for the students.

Figure 6

Awareness of the learning outcomes



However, the entrances with learning outcomes were quite short and descriptive, for example, "vocabulary" (almost every diary), "traditional dance" (Diary 3), or "daily routine" (Diary 7, 10).

These learning outcomes of vocabulary and cultural aspects go in accordance with the personal strategies of the students to search for the content they are really fond of. In three out of ten ethnographic diaries, students highlighted how the topics of interest were crucial in their personal approaches to language learning. For instance, one student found a topic of interest for her and started following specific influencers in Russian:

> *Gosto de ver vídeos de skincare, maquilhagem, viagens, "get ready with me". Com isto, para além de aprender a língua, aprendo também a cultura da Rússia. No instagram, comecei a seguir uma influencer russa e adoro!*
> [English translation: I like to watch skincare, make-up, travelling and 'get ready with me' videos. As well as learning the language, I'm also learning about Russian culture. I started following a Russian influencer on Instagram and I love it!] (Diary 8)

This type of strategy of finding a topic of vast interest in Russian and trying to search for more content on this topic in the target language, was prominent among the students.

Strategy 4. subtitles as a comprehension tool

The most prominent strategy for audiovisual comprehension was the use of subtitles. Around 69% of the students used subtitles, and Figure 5 shows that the language distribution in subtitles differs from the audio tracks, with English and Portuguese being much more dominant, with lower percentages of the target languages (Russian and Spanish). This indicates that students used English and Portuguese as the language mediators in their comprehension process. For example, one student reflected on her own use of subtitles, noting how they enabled her to enjoy engaging content that would otherwise be difficult to understand:

> *Para aprender, preciso que o tema me interesse. O que funciona para mim é ouvir em russo, com legendas em português ou inglês, seja filmes, séries ou vídeos.*
> [English translation: To learn, I need to be interested in the topic. What works for me is listening to Russian with subtitles in Portuguese or English, be it movies, TV shows, or other videos.] (Diary 8)

In this sense, subtitles ensure comprehension of the content that students are motivated to watch, being a crucial instrument in scaffolding language learning on social media.

Strategy 5. awareness of the limitations of language learning through social media platforms

Only one student reflected on the possible drawbacks of language learning beyond the classroom. For this student, the more problematic aspect of using social media in the target language was the difficulty of verifying if the information received was true. At the end of her diary, she mentioned:

> *Um possível malefício é que, dado que é uma ferramenta informal, não há garantia de que a informação que estamos a receber corresponda à realidade.*
> [English translation: One possible downside is that, since it's an informal tool, there's no guarantee that the information we're receiving corresponds to reality.] (Diary 6)

This student stood out as the only one who chose to watch political videos discussing the current political climate in Russia. As a result, her reflections focused on the challenges of assessing the trustworthiness of information sources. This is a particularly insightful observation, highlighting the need to support some students in navigating different aspects of language learning beyond the classroom, where additional scaffolding may be necessary.

In what ways do learners reflect on their language learning processes, including the development of personal strategies within social media contexts? (RQ2)

Alongside teacher notes, students' reflections on their language learning process during the creation and discussion of conceptual maps contributed to finetune the potential of the bridging activity to highlight learners' awareness related to the inner workings of social media and autonomous language learning online.

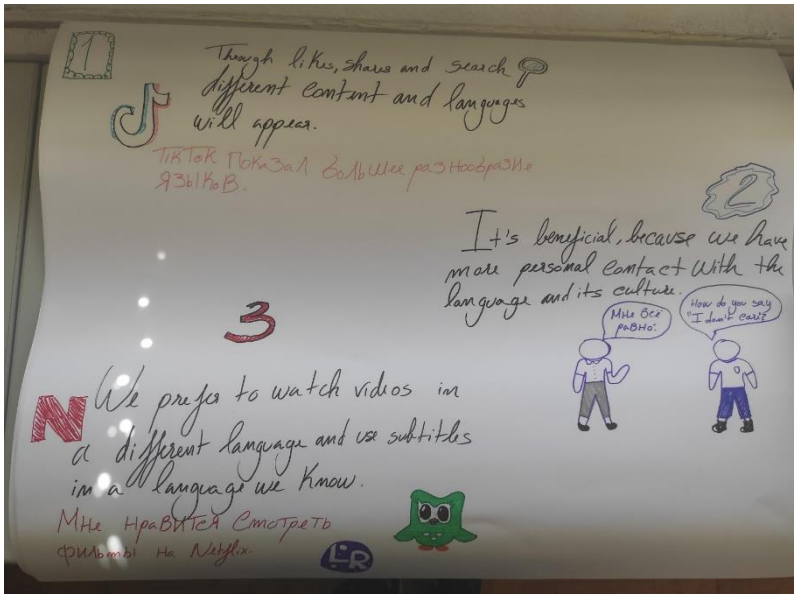
Phase 3: conceptual map discussion

The creation of conceptual maps took place during the second classroom session, with the primary objective to encourage reflection and discussion on the findings from the students' auto-ethnographic observations.

As the task was introduced as both multimodal and plurilingual, students incorporated multiple languages in their maps, including English, Russian, Spanish, Italian, and Portuguese. These maps also featured visual elements such as platform logos and dialogues. For instance, in Figure 7, we observe a combination of different languages, icons, and dialogues—some of which are presented in English and Russian.

Figure 7

An example of a conceptual map from a Russian class (Intermediate level)



Reflection on strategy 1. algorithmic reconnaissance and comparison

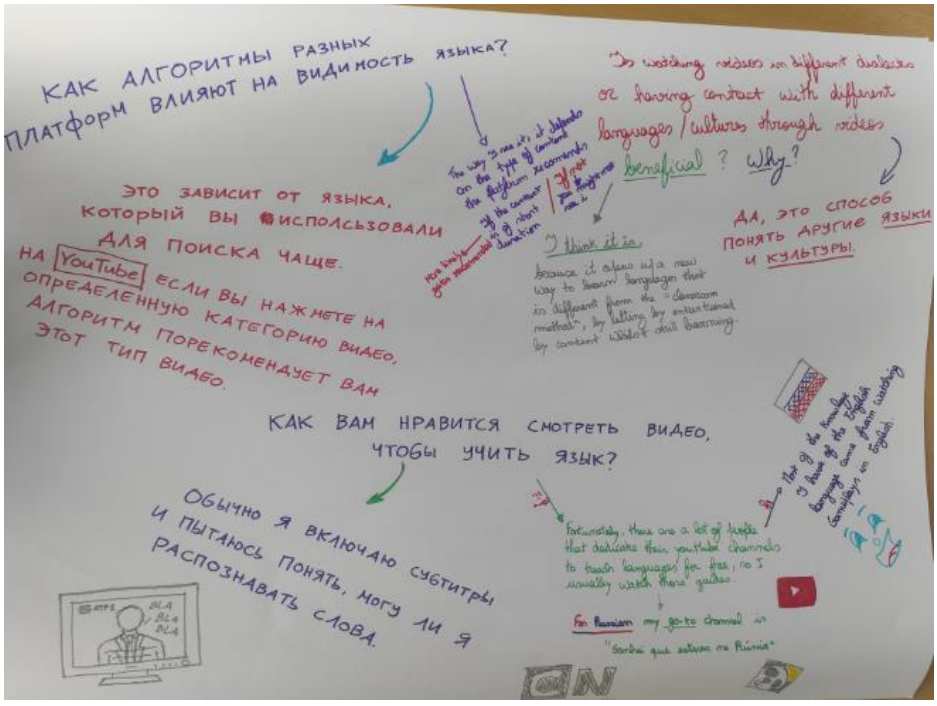
Most of the conceptual maps indicated that algorithms display videos in specific languages based on factors such as the user's search language, geographic location, likes, shares,

views, and platform settings. In Figure 7, for example, the first point on the map notes that through likes, shares, and search, different content and languages will appear. This insight mirrors the conclusion reached during our initial classroom discussion with students prior to the auto-ethnographic task. Some conceptual maps, however, provided more detailed reflections based on students' individual observations.

Some students made a cross-platform comparison, identifying which platform suffered the most significant algorithmic changes during the auto-ethnographic exercise. For example, in Figure 7, at the end of the first point, the students wrote: *ТикТок показал больше разнообразия языков* [TikTok showed more language diversity], hinting that TikTok was easier to manipulate during the auto-ethnographic task. Alternatively, in Figure 8, students note that: *на YouTube если вы нажмете на определенную категорию видео, алгоритм порекомендует вам этот тип видео* [on YouTube, if you press a specific video category, the algorithm will recommend this video type]. In this case, the students had more experience with using YouTube and could reflect on how video categorisation on the platform can help to adjust the algorithms.

Figure 8

An example of a conceptual map from a Russian class (Beginner level)



According to the teacher notes, during the maps' discussion, three out of four classrooms compared platforms in terms of algorithm changes, arriving at similar conclusions. This

cross-platform comparison suggests that students were actively reflecting on the role of algorithms in shaping language visibility.

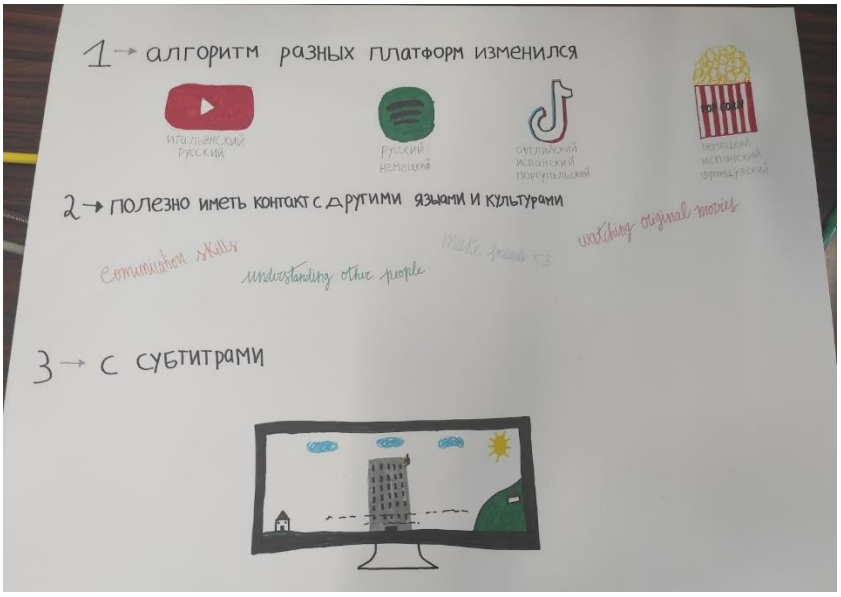
Reflection on strategy 2. refocus on other-than-English languages valorising the cultural and linguistic diversity

Through all the conceptual maps, students highlighted the value of engaging with target languages through social media, particularly emphasizing its benefits for learning about the cultural contexts of those languages. For example, in Figure 7, students noted: "It's beneficial because we have more personal contact with the language and its culture".

Moreover, in six out of ten maps, students went beyond focusing solely on target languages and instead recognized the broader cultural and linguistic diversity present in social media content. In Figure 8, for instance, students observed that watching videos provides opportunities to encounter various languages and cultures, which they found beneficial as "it is a way to understand different languages and cultures" [*Да, это способ понять другие языки и культуры*] Similarly, in Figure 9, students emphasized that "contact with different languages and cultures" [*контакт с другими языками и культурами*] can support the development of "communication skills" and contribute to "understanding other people".

Figure 9

An example of a conceptual map from a Russian class (Beginner level_2)



These reflections suggest that students' engagement with social media prompted a broader appreciation for multilingual and multicultural content, positioning social media as a meaningful pathway to exploring diverse linguistic and cultural contexts.

Reflection on strategy 3. subtitles as a learning tool

During the map's analysis, we noticed that students not only identified subtitles as a key tool for audiovisual comprehension on social media, but also described personalized strategies for their use, highlighting subtitles as a form of scaffolding in their language learning processes.

Subtitles are referenced in both Figure 7 and Figure 8. In Figure 7, students expressed a preference for extralingual subtitles, stating: "We prefer to watch videos in a different language and use subtitles in the languages we know." In contrast, Figure 8 reflects the use of intralingual captions as a deliberate learning strategy: "*обычно я включаю субтитры и пытаюсь понять, смогу ли я распознать слова*" ["Normally I put on the subtitles and try to understand if I can identify the words."]. These differences illustrate the individualized approaches students adopted based on their comfort levels and learning goals.

Teacher-researcher notes also recorded classroom discussions around subtitles versus captions. While captions (same-language subtitles) were generally considered more effective for language acquisition, they were also acknowledged as more demanding for comprehension. These insights suggest that learners were actively negotiating between accessibility and challenge when choosing how to engage with subtitled content.

Reflection on strategy 4. topic-driven "interest pathways" or content-creators as teachers

In four out of ten maps, students mentioned the types of content they were motivated to watch, often aligning with the idea of "interest pathways". These included gameplays (Figure 8), Netflix movies (Figure 7), films in original languages (Figure 9), and the experience of "traveling through videos by listening to real people from different countries" (M_6). Such examples highlight the diverse interests that drive students' engagement, as well as their motivation to listen to "real" voices and authentic stories from countries where the target languages are spoken. However, not all students favored informal or entertainment-based content. One map (Figure 8) emphasized the value of content explicitly designed for language instruction: "Fortunately, there are a lot of people that direct their YouTube channels to teach languages". This suggests that some students appreciate videos made by content-creators who take on the role of language teachers, rather than solely engaging with topic-driven or entertainment-based media.

These reflections reveal the diverse ways in which learners interact with content in target languages, underscoring that different approaches resonate with different students and can support language learning in multiple, personalized ways.

Reflection on strategy 5. limitations of language learning through social media platforms

Also, some students reflected on the limitations of language learning through social media platforms, though the issue of the difficulty of verifying information was not mentioned. Instead, similarly to the introduction class discussion, students discussed how social media video content could not replace interaction.

For instance, in one group (Russian, beginner), a discussion occurred concerning how videos, even though useful for language learning, could never replace live interaction with people, which is considered the most important aspect of language learning. It was also reflected in the Map (M_2) where the students wrote that "watching content is beneficial but not to the same degree as human interaction".

Overall, the analysis of the conceptual maps showed that students reflected on the five main language learning strategies identified during the initial classroom session and the development of their ethnographic journals. They paid particular attention to the visibility of language on social media platforms and its relationship with algorithms. Additionally, subtitles and captions emerged as a key strategy for autonomous language learning through social media.

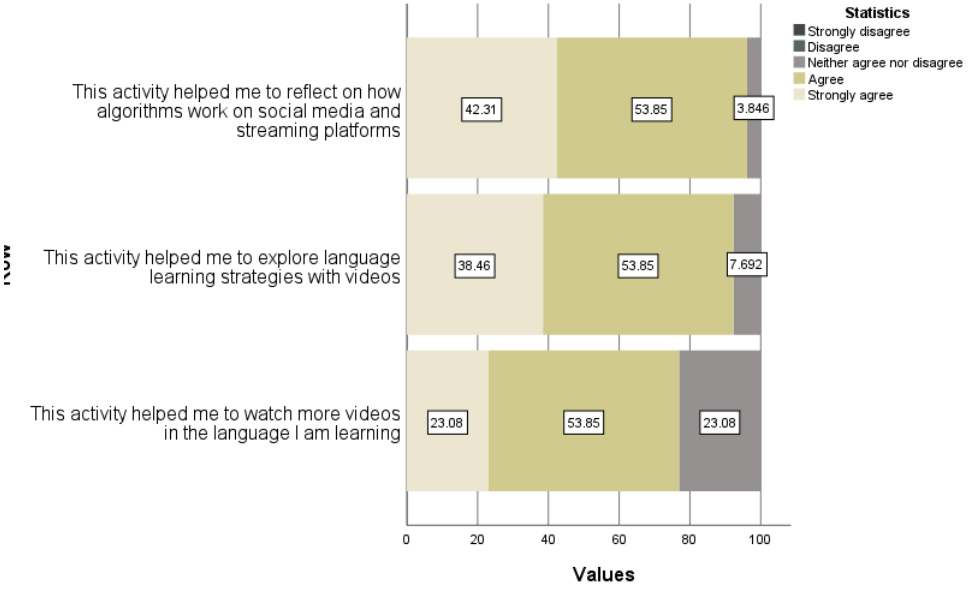
What are the learners' perceptions of their algorithmic awareness and language learning autonomy development? (RQ3)

In this section, we will discuss the students' perceptions of their autonomous language learning during the activity and their algorithmic awareness.

To assess students' perceptions, the questionnaire included three Likert-scale items related to autonomous language learning (Scales 2 and 3 in Figure 10) and algorithmic awareness (Scale 1 in Figure 10). As shown in Figure 10, responses across all three scales were overwhelmingly positive, no participants selected the negative options, such as "disagree" or "completely disagree."

Figure 10

Likert scales on students' perceptions of the learning outcomes



Despite this overall positive trend, some differences emerged among the scales. The algorithmic awareness scale received the highest proportion of "strongly agree" responses (42%) and the fewest "neither agree nor disagree" responses (3%). In contrast, the scale on target language video consumption showed the lowest percentage of "strongly agree" responses (23%) and the highest percentage of "neither agree nor disagree" responses (23%). We interpret these differences as indicative of how students perceived the focus of the bridging activity. Specifically, students appeared to view the activity as more effective in developing transferable skills, such as algorithmic awareness and learner autonomy, than in simply increasing the quantity of target language video consumption.

Moreover, the activity was perceived by students as beneficial for language learning, particularly in supporting vocabulary acquisition and exposure to multiple languages and cultures. In response to the yes/no question "Could this activity help you in learning other languages?", 88.5% of students answered affirmatively. Their responses to the open-ended follow-up question "How?" revealed three main themes: (1) Plurilingual and cultural exposure, (2) Vocabulary development, and (3) Search for content in target languages.

Four students pointed to the value of plurilingual and cultural exposure (1), as expressed in one answer: "*Porque así estoy en contacto con más idiomas y culturas"* [because in such a way I am in contact with different languages and cultures]. Moreover, three students emphasised exposure and vocabulary development (2), as illustrated by one response:

> By getting constant exposure to a certain language, we can increasingly become more fluent and learn words and expressions we wouldn't be able to learn in class.

Finally, one student highlighted the benefit of learning to search for content in other languages pointing at algorithmic awareness (3): "It can teach how to search for specific content in other languages". These post-activity reflections go along with the discussions raised from the map construction, particularly highlighting the strategies focused on autonomous language learning and linguistic and cultural diversity.

Additionally, the positive outcomes were supported by the open-answer section of the questionnaire, where students outlined the benefits and drawbacks of the bridging activity. Among the positive aspects, 26 responses were captured and categorized into five categories: Discover new language learning strategies (12), Role of algorithms in language visibility (10), Noticing cultural/language varieties (8), Fun activity (2) and Group work (2). We can see that the first two of these categories mirror our pedagogical goals including algorithmic awareness development together with autonomous language learning.

In the first category, students emphasized that the activity helped them discover "*as distintas formas de aprendizagem*" [different ways of learning], recognizing language learning as a process that extends beyond the classroom. One student articulated this view clearly: "This activity helped me explore new ways of learning a language and not seeing Russian just as a subject."

In the case of algorithms, students reflected on them as a way to see more content in other languages and also to create a habit of it. We received such answers as:

> *He aprendido como funcionan los algoritmos de las aplicaciones y lo que puedo hacer para ver más vídeos en otras lenguas*
> [English translation: I learned how algorithms function and what I can do to watch more videos in other languages].

Students clearly connect the algorithms' function with the visibility of different languages and how they can influence these algorithms being an active and more conscious consumer of social media content.

In the third category, noticing cultural and language varieties (8 responses), students' reflections extended beyond the previously identified strategy of "Refocus on other-than-English languages." Their comments indicate a deeper awareness of linguistic diversity. For example, one student noted: "*Intenté diferenciar los dialectos de las lenguas, antes no lo hacía*" [English translation: "I started trying to differentiate the dialects of different languages, which I didn't do before"]. Others mentioned that the activity helped them

"understand other cultures and languages," echoing reflections shared during the map construction phase.

These responses highlight students' generally positive perceptions of the activity, particularly in relation to language learner autonomy and algorithmic awareness. The activity appears to have prompted meaningful reflection on what it means to learn a language, encouraging learners to see themselves as active agents in their own learning processes.

Of the 26 responses regarding negative aspects of the activity, 19 students did not report any. Among the 7 who did mention drawbacks, a few (2) expressed mild dissatisfaction with the format of the activity—specifically, the use of PowerPoint presentations, which they found somewhat unengaging. However, the majority of critical comments were not about the activity itself, but rather about personal realizations students had during the process. These included concerns about the amount of time they spent on social media (4) and the limited linguistic and cultural diversity present in their feeds (1). Importantly, these reflections indicate that the activity prompted students to critically evaluate their digital habits, particularly in relation to time management and content exposure, further highlighting the value of raising awareness about social media use in educational contexts.

Discussion

This study supports previous research on learner autonomy (Benson, 2016; Borg & Al-Busaidi, 2012) by valuing and building upon students' experiences beyond the classroom. Furthermore, it explores the specific dynamics of promoting learners' autonomy within social media environments, with a particular focus on algorithmic awareness as a potential pillar of language learner autonomy development in this context.

The results revealed that students organized their informal language learning practices around five different strategies: *(1) Algorithmic reconnaissance and (2) Refocusing on languages other than English, (3) Using subtitles as a comprehension tool, (4) Following topic-driven "interest pathways," and (5) Becoming aware of the limitations of language learning through social media platforms*. During the map construction process, students reflected on these strategies in multimodal ways. In what follows, we discuss these strategies alongside student reflections to provide a comprehensive picture of their algorithmically informed Learning Beyond the Classroom (LBC) experiences.

Regarding the strategy of *algorithmic reconnaissance*, analysis of the teacher's fieldnotes revealed that students discussed several tactics to influence their social media algorithms: (1) searching in their target languages, (2) liking or following content in those languages, and (3) watching videos to the end and engaging with the comments. Following this discussion in the first classroom session, students began applying these tactics in their diary entries. Their efforts to diversify their feeds beyond English became increasingly evident,

first in their written reflections and later in the conceptual maps discussed during the second class. This progression suggests that students were developing algorithmic awareness, which, according to Shin et al. (2022), rests on users' accountability and their ability to engage meaningfully with algorithms.

The analysis of the concept maps further revealed that students engaged critically with the strategy of *algorithmic reconnaissance*. During the map construction process and subsequent classroom discussion, students compared on their experiences across platforms such as YouTube and TikTok, noting how different algorithms shaped the content they were recommended. Such comparative reflection further points to the development of algorithmic awareness (Burrell et al., 2019), which in turn served as a tool for organizing their language learning environments (Benson, 2020).

In the strategy *refocusing on other-than-English languages*, and in line with Shafirova & Araújo e Sá (2025), students reported using a variety of languages, particularly their target languages, Spanish and Russian, while completing their auto-ethnographic diaries. During the concept map construction phase, students further reflected on the *refocus on other-than-English languages* strategy, discussing how social media allowed them to explore different linguistic varieties within their target languages and notice cultural nuances. These reflections align with prior research on bridging activities (Miller et al., 2019; Yeh & Mitric, 2021), which demonstrate the value of such approaches in enhancing students' cultural awareness. However, this study shifts the focus from engaging with a single 'target culture' to adopting a more plurilingual perspective, encouraging students to interact with multiple languages, language varieties, and cultural contexts. In doing so, it illustrates how linguistic and cultural diversity can be integrated into algorithmically-informed LBC.

In the strategy *subtitles as a comprehension tool*, subtitles and captions emerged as valuable resources for audiovisual comprehension and vocabulary acquisition, reflecting a substantial body of research supporting their effectiveness in these areas (Danan, 2004; Montero Perez et al., 2014). Beyond these well-documented benefits, our findings indicate that learners also adapted subtitles and captions in highly personalized ways, an approach that resonates with research on language learning "in the wild" (Shafirova & Cassany, 2017). This highlights their potential as individualized tools for LBC in social media environments.

The most common strategy for incorporating target languages into students' online environments was the *topic-driven "interest pathways"* in which students searched for personally engaging content in those languages. This preference for relevant and motivating content, rather than just comprehensible input, aligns with prior research on informal language learning (Reinders, 2010; 2021) and stands in contrast to the more structured and input-focused approach of traditional language courses (Patrick, 2019). This

idea of consuming engaging content through social media is constructed through algorithmic awareness, in which the students consciously feed the algorithm with the type of video they want to watch in a specific language, being another valuable strategy of algorithmically-informed LBC.

Importantly, during the construction of their digital learning environments, some students also reflected on the *limitations of language learning through social media platforms.* This student-emergent strategy revealed concerns about the credibility of information encountered on social media, particularly when engaging with content in different languages. Such critical awareness represents an important dimension of learner autonomy, suggesting that students are beginning to question and evaluate the quality of their learning sources—an area where teachers can play a key role in scaffolding students' critical analysis of digital content. However, there was a limited number of students noticing this type of limitations suggesting that the dimension of critical reflection on limitations may require additional support within the design of the bridging activity. In general, according to these findings, the discussion of the first classroom and auto-ethnographic diaries helped the students to navigate, organize and reflect on their informal language learning practices in social media environments.

Furthermore, based on the post-activity questionnaires, students perceived the proposed tasks as effective in developing strategies for autonomous language learning—strategies they believed could also be applied to learning other languages. Among the Likert-scale items related to (1) autonomous language learning, (2) access to content in the target language, and (3) algorithmic awareness, responses regarding algorithmic awareness were the most positive. This suggests that students recognised knowledge of algorithms as particularly valuable for shaping their language learning strategies. Similarly, in the open-ended responses, several responses emphasised the role of algorithms in increasing the visibility of different languages online, with some explicitly linking this to their language learning experiences.

Overall, students' reflections on language learning in social media environments highlighted the wide range of opportunities they perceived, especially in terms of vocabulary development and plurilingual learning (i.e., visibility of language varieties and cultural contexts). They also emphasised the importance of subtitles and captions as key tools in their autonomous learning. Finally, the data suggest that students connected the role of algorithmic awareness in their autonomous language learning, associating it with further understanding of how linguistic content becomes visible and accessible on social media.

Limitations

This exploratory study presents several limitations. First, the small scale of the study, the limited number of participants and low rate of the task completion restrict the transferability of the findings. Because the auto-ethnographic activity was optional and not formally assessed, only 38% participants completed the diaries. This reduced participation limited the depth of the data collected. In addition, the study was situated within the specific cultural, institutional, and social context of a Portuguese university, where academic practices, assessment cultures, and students' engagement with social media may differ from those in other settings. These factors require caution when applying the findings to other contexts.

A further limitation lies in the absence of longitudinal observation of students' social media use following the activity. Without follow-up data, it is difficult to evaluate the long-term impact of the activity on students' language learner autonomy. We consider this the most significant limitation and recommend that future studies on this topic include a longitudinal component to better assess sustained learning outcomes.

Implications for practice

Although the findings of this study are not directly transferable to other educational contexts, they point to several strategies that may be worth exploring in language classrooms, including:

- **Integrating the algorithmic awareness as part of the language pedagogy.** Teachers can guide students to experiment with social media search patterns, engagement, and platform features. This can help learners actively shape their digital environments, strengthening their learner autonomy on social media and streaming platforms.
- **Encouraging personalized learning through interest-driven content.** Teachers can give value to students' individual strategies for consuming interest-driven content by creating space in the classroom to share these strategies and interests, and by discussing and valuing learners' individual approaches to comprehension and learning.
- **Scaffolding critical awareness and evaluation of online content.** Given that only some students reflected on the limitations and credibility of social media content, teachers can include explicit prompts and criteria to support critical evaluation of the social media content in the target language.

Conclusions

This study contributes to ongoing discussions about fostering language learner autonomy in social media environments by introducing algorithmic awareness as a key component in the design of bridging activities. While the research was conducted in a specific context, it provides valuable insights into various approaches for promoting learner autonomy beyond the classroom. These insights align with the emerging concept of proactive language learning, which integrates informal, non-formal, and formal learning practices (Papi & Hiver, 2024). Such an approach offers promising directions for university language courses aiming to cultivate lifelong learning skills. Future research could explore similar pedagogical designs in diverse educational contexts, including high school students and pre-service language teachers, contributing to both the conceptual and practical development of digital literacies, particularly by incorporating algorithmic awareness alongside AI literacy. This integration of digital, algorithmic, and AI literacies, combined with a critical understanding of how technology shapes linguistic and cultural diversity, is essential for building a comprehensive vision of technology-mediated language education in the years ahead (Kohnke et al., 2025).

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Author's contributions
Authors' contributions are detailed according to the CRediT (Contributor Roles Taxonomy) model. The first author was responsible for Conceptualization, Methodology, Data analysis, and Writing the original draft. The second and third authors contributed to Data analysis and Writing (review and editing).

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Availability of data and materials
The data supporting this study are not publicly available, as participants did not provide explicit consent for data sharing in the ethical informed consent agreement.

Declarations

Competing interests
The authors declare that they have no competing interests.

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