Minerva: An Adaptive and Personalized Solution for Organizing Studies Based on Learning Cycles

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Abstract. *This paper presents Minerva, a mobile application designed to help students organize their study routines through adaptive and personalized learning cycles. Grounded in principles such as meta-cognition, spaced repetition, and self-regulated learning, Minerva offers features like a habit tracker, learning trail, progress dashboard, and intelligent scheduling. Unlike traditional study methods, the application enables users to dynamically adjust study goals based on personal performance and availability, promoting autonomy and motivation. An exploratory study involving 50 students was conducted based on the UTAUT model. The results indicate a high level of acceptance of the app's concept, particularly among students with no prior experience using similar tools. Participants emphasized its innovation, usefulness, and potential impact on their study habits. While still under development, the proposal demonstrates its potential to the scientific community by integrating evidence-based educational theories with user-centered design practices. This study contributes to the advancement of adaptive educational technologies. It opens up discussions for future investigations into the efficacy of learning cycle-based study tools.*

1. Introduction

In the academic context, students face considerable challenges in structuring their study routines, as conventional methods based on fixed schedules disregard the uniqueness of each student. This rigidity can lead to cognitive overload, demotivation, and problems balancing academic, personal, and social commitments. The lack of adaptive mechanisms in study management tools exacerbates the problem, as unforeseen changes in students' routines often affect rigid schedules, diminishing their effectiveness and long-term use [Locke 1987]. Recent research corroborates this context, pointing out that adaptability in the learning process is directly linked to self-regulation and academic motivation [She et al. 2023].

Several technological tools, such as Forest and Focus To-Do, have been developed to support study time planning and self-regulation, offering features like productivity control and focus techniques. However, it is common for such approaches to fail to include

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methods tailored to the student's profile, based on solid pedagogical principles. Both older and more recent studies emphasize the importance of spaced repetition in solidifying long-term memory [Ebbinghaus 1885], as well as the practice of recall in improving content retention [Roediger and Butler 2011]. Metacognition emerges as a key element in monitoring one's own learning [Flavell 1979], while self-directed learning fosters autonomy and interest [Zimmerman 2002]. Finally, Self-Determination Theory emphasizes autonomy as vital to motivation [Deci and Ryan 2000].

Research on applications that combine adaptive learning cycles and dynamic scheduling, enabling adjustments based on performance, availability, and goals, is still limited. Given this, it is crucial to adopt approaches based on concrete data and place the student at the center.

Considering how to address this issue, we introduce Minerva, a mobile app that assists students in planning their study schedules using flexible and personalized learning cycle systems. Based on concepts such as metacognition and self-determination, the app enables users to set goals, track their progress, and reflect on their performance. Its premise is that management systems should not impose rigid structures, but rather adapt to the student's context, promoting sustainable habits [Corno 2008]. In addition, adaptability is crucial for optimizing learning [Akella 2010].

Based on this idea, this study aims to investigate the application of personalized learning cycles in a mobile application. We aim to investigate how such cycles influence the structuring of learning and examine students' perceptions of the usefulness, novelty, and importance of Minerva in their daily academic lives, as well as identify the primary strengths and weaknesses in the initial evaluation of the prototype. To obtain answers to these questions, a survey was conducted involving 50 students, using a framework based on the Unified Theory of Acceptance and Use of Technology (UTAUT) [Gonzales et al. 2017]. Preliminary results indicate high acceptance of Minerva, particularly among students with no prior experience with similar tools, providing initial evidence of the app's impact on study habits and informing its future development.

2. Theoretical Background

Experiential learning is a process of constructing knowledge through reflection on experiences, transforming these experiences into knowledge applicable to future situations [Kolb 2014]. This structure emphasizes the priority of active learning and student participation in their own development, enabling teaching tailored to individual skills, interests, difficulties and needs, promoting greater engagement and autonomy in the educational process. In the case of Minerva, experiential learning underpins the design of functionalities, encouraging not only constant practice in the construction and adaptation of cycles but also reflection on one's own study habits.

Metacognition involves awareness and regulation of one's own learning processes, including planning, control, and analysis of established strategies and habits, which builds metacognition [Flavell 1979]. Developing one's own ability to self-regulate enables academics to identify gaps, adjust their behaviors, and enhance their study outcomes. User-friendly tools that incorporate metacognitive principles, such as habit trackers and progress dashboards, enable users to reflect on their performance, providing ongoing feedback and fostering continuous self-reflection.

Self-regulated learning refers to the student's ability to plan, monitor, and adjust their study strategies to achieve specific goals [Zimmerman 2002]. The study cycle, applied in Minerva, represents a practical approach to self-regulation, organizing study sessions and goals in a continuous and adaptive manner. The tool enables students to dynamically adjust their goals and track their progress, supporting both discipline and autonomy, and fostering the development of consistent and personalized study habits, thereby differentiating itself from other study organizations.

Cognitive load theory emphasizes the need to structure information in a way that does not overload working memory, which optimizes the learning process [Sweller 1988]. At Minerva, the study design, which incorporates block scheduling, visual dashboards, and adaptive cycles, contributes to reducing cognitive overload and enhancing learning efficiency. In Brazil, challenges in education, such as unequal access and low adherence to structured methods, are documented by national organizations, including the Brazilian Society of Informatics in Education (SBIE) and the Brazilian Journal of Informatics in Education (RBIE). This demonstrates the importance of adaptive and inclusive educational tools [Siqueira and Moreira 2023].

3. Related Works

This section presents and discusses applications and studies related to this work.

Platforms such as Khan Academy validate the potential of adaptive educational tools [Koedinger et al. 1997], but they are generally limited to pre-structured content. Minerva advances by integrating: i) intelligent time management, based on prioritization algorithms; ii) continuous feedback, according to the principles of self-regulated learning; and iii) flexible scheduling systems that allow for non-linear progress.

Table 1. Comparison between Minerva and related tools

Tool	Main features	Limitations	Differentials of Minerva
Khan Academy	Structured lessons, adaptive exercises	Limited to platform content	Flexible cycles applicable to any subject
Forest	Focus timer with gamification	Not learning-oriented, limited for long-term consistency	Integration of focus management with study cycles
Planejativo ENEM	Comprehensive study plan for ENEM with summaries, exercises, video lessons, and difficulty levels	Requires fixed daily schedules and study hours, limited flexibility for unexpected events	Generation of adaptive cycles, adjustable frequency, balance between structure and autonomy

The Forest app [Feng et al. 2019] focuses on promoting concentration through a gamified timer. Although effective for immediate focus, its design does not promote long-term consistency and is not directly aligned with learning goals.

In the Brazilian context, the Planejativo ENEM app provides personalized study plans for the National High School Exam, including summaries, practice questions, and video lessons. Although it is comprehensive and offers some options for difficulty levels and flexibility, its model remains quite rigid. Users must follow exact daily schedules and devote specific amounts of time to each subject, which may not adapt well to unforeseen circumstances or students who prefer a less restrictive approach. In addition, some recurring complaints from users focus on the lack of greater process automation, limited customization options, and slow real-time performance updates [e Tecnologia LTDA 2021], aspects that compromise the user experience and reveal weaknesses in the system's ability to adapt to individual needs.

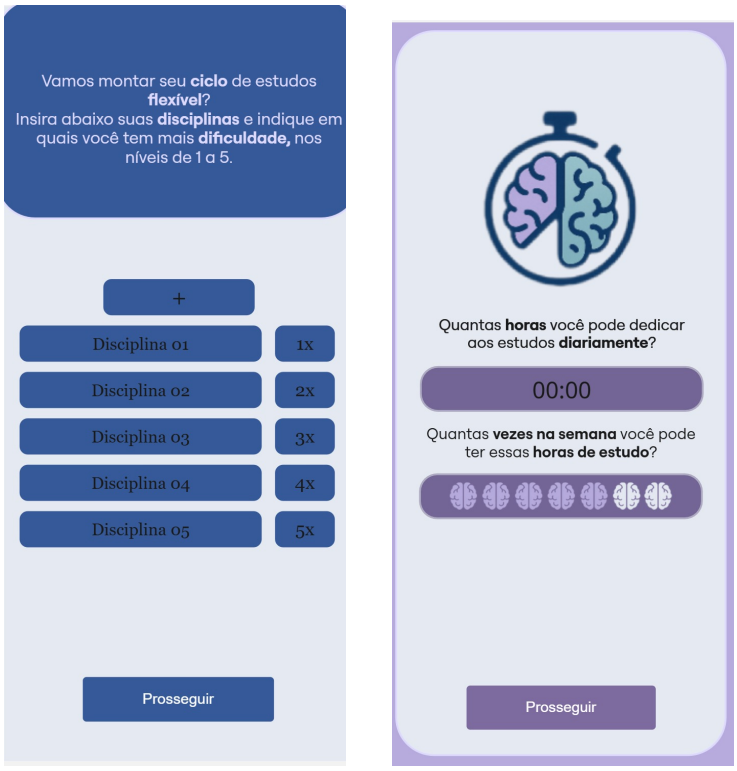
Table 1 summarizes the main features and limitations of these tools and highlights the unique features of Minerva. In this way, Minerva stands out for integrating time management, cycle customization, and self-assessment mechanisms into a single environment, thereby overcoming the limitations observed in the analyzed tools.

4. Minerva

Many students today face a characteristic difficulty in their studies: organization. The difficulty of managing their time and balancing academic, personal, professional, and social life becomes a recurring challenge in their daily lives. Observing this context, Minerva seeks to develop personalized study control based on specific and individual data, thus facilitating the integration of study cycles into students' routines. This approach makes study cycles more flexible and customizable, and makes time management more accessible to users. Several specific features are necessary, arranged in a dynamic and interactive way. The essential details for logistics and operations are as follows:

- **Learning Trail:** In this area, consisting of three phases, information is collected and stored. These include available time, accessible days per week, subjects studied, and any associated difficulties. A student with two hours allocated to study per day will have cycles proportional to the declared difficulties. This information will be analyzed and worked on mathematically to map out the next steps and develop a personalized and flexible cycle.
- **Daily Overview:** This is where users can track their daily progress, observe and work on the study cycle developed, and view a graph to track the progress of the current cycle. Students can analyze their progress through graphs.
- **Habit Tracker:** At this point, the user's studies will be recorded daily, divided into half-hour blocks, and represented by a checklist (with check-boxes). Rewards, badges, and consistency statistics will be made available, along with motivational phrases that will also serve to engage and encourage the student.
- **Progress Dashboard:** Here, users can see their personal development within the app after a certain number of cycles, including graphs showing progress by subject, accumulated time, and completed cycles, highlighting not only progress in hours but also the student's learning development, showing which areas the student is excelling in or still needs to reinforce. This enables the tracking of completed study blocks and the time required to complete each cycle.
- **Restart Track:** With this feature, it will be possible, over time, to update the individual cycle or, if necessary, create a new cycle from scratch, making it an

option that can be adapted to changes in routine, new content, or test preparation, ensuring continuous progress because the user is not tied to a rigid system. This is a feature not found in other applications, which require users to start from scratch. Thus, the application becomes completely adaptable and flexible to the user's reality.



(a) Weekly hours availability

(b) Subjects included in the cycle

Figure 1. Data collection for cycle generation

5. Methodology

The performance of a study depends largely on the methods chosen by the research team [Cervo and Bervian 1996]. This research is characterized as an applied study, with the aim of addressing a practical problem—specifically, the evaluation of the Minerva design prototype—through a mixed-methods approach that combines qualitative and quantitative data. The main objective was not to test a fully functional application, but rather to analyze the proposed interface and key features presented in the prototype, as well as to collect students' perceptions of its potential use.

The prototype was created in accordance with user-centered design principles, aiming to make the organization of studies more flexible and intuitive. The screens were first designed in Canva and then transferred to Miro, allowing for the construction of an interactive, non-functional prototype accessible on both mobile devices and computers. The core logic was based on a brief integration questionnaire with two questions (chosen subjects and perceived difficulty), which generated suggested 30-minute study blocks. This duration was set as a reference value, but the system was designed to allow adjustments for shorter periods, depending on student availability. Before evaluation,

the research team conducted internal tests to ensure consistency in navigation flows and clarity of the proposed design.

To evaluate the prototype, the UTAUT (Unified Theory of Acceptance and Use of Technology) model [Gonzales et al. 2017] was adapted to the educational context. The evaluation was conducted with students from integrated technical courses at the Federal Institute of Maranhão (IFMA). A questionnaire was administered via Google Forms, combining Likert scale items for quantitative assessment with open-ended questions to capture qualitative feedback on usability and perceived usefulness.

Responses were analyzed using a mixed-methods strategy. Quantitative data were tabulated in Microsoft Excel and Google Sheets to identify trends and distributions, while qualitative feedback was examined through content analysis, grouping student opinions into themes such as design quality, functional relevance, and suggested improvements. This triangulation ensured a deeper understanding of students' acceptance of the prototype and the perceived value of its proposed functionalities.

6. Ethical Considerations

To ensure maximum consideration for the rights of each participant, the study established very strict ethical guidelines. Before agreeing to participate, students received extensive details about the purposes, approaches, and potential risks, and were free to withdraw from the study at any time without any negative consequences.

The data collected was handled with the utmost care, and each person's individuality was preserved. Participants' personal details were kept secure to prevent any unauthorized access or disclosure of information. Only the research team was allowed access. The project complied with the rules defined by national and internal research institutions on studies involving human subjects.

Special attention was given to minimizing any psychological or social harm, given that the research focuses on topics related to study practices. Participants had the opportunity to discuss with the team any uncertainties they may have. In this way, the research ensured the utmost respect for the rights, privacy, and comfort of all participants.

7. Preliminary Results

The survey received responses from fifty participants, mainly students from the Federal Institute of Maranhão (IFMA) - Pedreiras and other institutions.

Overall evaluation of the proposal: As shown in Table 2, the majority evaluated the idea positively, with over 70% strongly agreeing with the statements about its quality, effectiveness, and potential recommendation.

Experience with similar applications: Most participants (82%) had never used study organization applications, while 18% mentioned tools such as Quizlet, Forest, Focus Tree, and Planejativo, valuing their productivity features.

Qualitative feedback: Students emphasized the usefulness and innovation ("Very useful and interesting app"), the potential impact ("It looks promising and will help many students manage their routine"), and the interface and proposal ("Great initiative; it meets an important need"). Suggestions included more customizable schedules, options for different study periods, and improved goal tracking.

Table 2. Overall evaluation of the Minerva app proposal

Statement	Strongly agree	Agree	Neutral	Disagree
The idea behind the app is good	73.7%	21.1%	5.2%	0%
I believe the app will be effective	76.3%	18.4%	5.2%	0%
Minerva's proposal is interesting	68.4%	26.3%	5.2%	0%
I'd recommend it to friends	71.1%	21.1%	5.2%	2.6%

Overall, the results indicate high acceptance of the *prototype proposal*, with adaptable study cycles standing out as a notable innovative element. The findings reinforce the viability of Minerva as a study organization tool, while pointing to refinements to be considered in the next stage of development, which involves functional implementation.

8. Contributions, Limitations and Future Work

This research offers a valuable addition to the field of technology in education, introducing Minerva, an adaptive study app designed to help students organize their study schedules. The app leverages well-known concepts such as distributed practice, self-analysis of learning, autonomy, and flexible planning, encouraging personalized learning and student autonomy. Initial analysis revealed that Minerva has the potential to enhance study habits, interest, and motivation, as well as provide insights into the development and application of educational technologies that cater to individual needs.

Despite this, there are several areas for improvement: the number of participants was small (50 students), the evaluation was brief, and ease of use and participant enjoyment were assessed solely by their responses. Additionally, the app is limited in its functionality, only working with specific types of tasks, which restricts its overall use. Future research should increase the number and variety of participants, conduct longer studies to examine long-term effects, incorporate more types of tasks and tools to customize them based on data, and explore ways to maintain interest, utilize game elements, and provide quick feedback to enhance motivation and learning outcomes.

9. Final Remarks

This research details Minerva, a customized study app designed to help students plan their study strategies, utilizing tailored and flexible learning methods. The initial analysis indicates that combining proven educational concepts (such as gradually reviewing material, reflecting on learning styles, developing willpower, and organizing study schedules) in an app that promotes student independence, interest, and engagement is highly effective.

Even with these promising initial results, it is essential to conduct further research to determine if the app truly aids learning in the future and to refine it further based on user feedback. By combining theory with a project designed for students, Minerva demonstrates that technology in education can be a valuable aid in various types of learning.

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