

Advancing Study Planning with Learning Analytics

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Abstract: Students must create study plans that balance individual academic goals with institutional requirements, including examination regulations, prerequisites, and module constraints. This paper presents a prototype study planner incorporating examination regulations through a Constraint Modelling Language (CML) derived from eight examination regulations. Additionally, it offers a Learning Analytics Dashboard to visualize study progress, peer comparisons, and module recommendations. The CML was validated through expert evaluation, and the prototype was assessed using think-aloud usability testing.


Keywords: Study Planning, Learning Analytics, Constraint Modelling, Recommender Systems

1 Introduction and Related Works

Planning a university degree presents significant challenges for students. The range of available modules and possible module combinations is vast, examination regulations are complex, studies extend over multiple years, and individual goals evolve throughout the degree as students discover their interests, assess their performance, and observe peers' preferences. Therefore, students repeatedly ask for a tool to support the creation of study plans that balance individual academic goals with institutional requirements, including examination regulations, prerequisites, and module constraints. The design and development of such a tool is based on preliminary work ranging from academic progress analysis, study planning strategies, and course recommendation systems to learning analytics and existing study planning tools.

Academic progress data provides insights into students' planning behavior and performance, informing future decisions. [Na14] analyzed 12,836 engineering students, finding that poor first-year performance increases non-completion risks and that students investing more time per ECTS achieved better outcomes. [Se22] examined 1,898 mathematics and computer science graduates, showing that concurrent enrollment reduces study duration while taking modules from other faculties and skipping semesters negatively impact completion. These historical patterns can inform study planning strategies and tools.

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[Mo15]’s IDiSC+ extends course planning by incorporating institutional constraints and student preferences to generate study plans through iterative refinement. It has demonstrated effectiveness for students facing expulsion risks due to poor planning. [RT20] developed an algorithm prioritizing course enrollments by calculating “slack” (temporal buffer) based on prerequisites and requirements. Testing with 102 participants showed 82.1 % of newcomers felt less anxious, 98 % rated plan usefulness 7+ on a 10-point scale, and all participants rated preference alignment 7+.

[Be09] developed CourseRank, a course recommendation system for Stanford students, integrating social features and course ratings to support study planning. [PVG11] extended this by exploring recommendations under complex constraints, finding that course popularity often aligned with historical enrollment patterns. [Yu21] showed that explanations in recommendations, especially those based on thematic overlap, increased users’ serendipitous course discoveries.

[Ju23] tested a study planner with 12 computer science students using think-aloud methodology, identifying requirements including university account integration, authentication, multiple plan drafts, and peer plan alignment. [Ba24] conducted similar studies with 20 students, recommending that user interfaces follow university design while remaining intuitive, include course filtering, and provide support functions to prevent planning errors.

Self-regulated learning (SRL) enables students to manage their studies through goal setting, planning, monitoring, and reflection [Zi15]. Although key SRL models offer valuable frameworks [PKJ15], they are rarely applied to study planning at a macro level. Recent Learning Analytics research uses SRL as a theoretical foundation, with tools like dashboards [Sc16] and recommender systems supporting progress tracking and peer comparison.

The reviewed related works on study planners provide requirements and functionalities tested in user studies. Since these primarily address usability and design aspects, insights from academic progress data, planning strategies, and course recommendation systems must also be considered to ensure comprehensive study planning support. Additionally, Self-regulation applied technically in Learning Analytics applications could enable students to reflect on their academic planning and history while identifying actionable next steps.

2 StudyPlanner

StudyPlanner is a web-based application streamlining academic planning through a visual interface. Built with Vue.js and the headless CMS Strapi, it supports valid academic progression planning by loading enrollment and exam data from external sources like university data warehouses. The software architecture is summarized in Figure 1. Based conceptually on [Ju23], the interface provides a user-centered design allowing students to plan and manage modules through an intuitive graphical representation of their academic

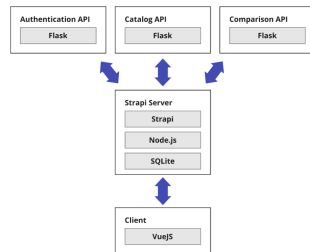


Fig. 1: Software Architektur

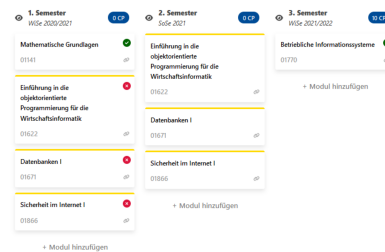


Fig. 2: User Interface of the study planner

trajectory (Figure 2). Users can add or remove modules and semesters dynamically for flexible study path adjustments. System usability was evaluated through interviews and think-aloud testing (N=6).

Constraint Modelling Language Examination regulations are legal texts that contain precise rules about which combinations of modules must be completed to finish a degree program. From these individual rules, generic rules can be identified that are found in multiple examination regulations. We analyzed all eight examination regulations of the degree programs in the Faculty of Mathematics and Computer Science at FernUniversität in Hagen. We identified eight generic rules that describe the regulations entirely. Following [Co23], we formulated these rules as constraints and transformed them into a JSON-based constraint modeling language (CML). Within the StudyPlanner, this CML and the required module catalogs can be configured in the Strapi web frontend, allowing students to validate their study planning according to their applicable study regulations. The constraint system includes eight generic rules that describe examination regulations. These rules specify minimum (`moduleMin`) and maximum (`moduleMax`) numbers of modules from catalogs, define mandatory modules (`mandatoryModules`) for degree programs, and group catalogs under superordinate structures (`moduleGroupDefinition`). The binding module rule (`bindingModule`) prevents students from changing elective compulsory modules after exam participation, while credit requirements (`minCreditsFromModuleGroup`) ensure sufficient credits from specific catalogs. Alternative scenarios are handled through logical OR operations (`or`), and prerequisite dependencies (`requiredModules`) define which modules or catalogs must be completed before enrollment in others. An expert responsible for ECTS monitoring at FernUniversität in Hagen has successfully evaluated the constraints.

Learning Analytics Dashboard The dashboard (Fig. 3) features six widgets that provide students with comprehensive study progress and planning information. The first row contains four progress metric widgets that track individual study advancement. Progress bars offer visual support and tooltips displaying percentage completion for metrics with calculable



Fig. 3: Learning Analytics Dashboard in the StudyPlanner



Fig. 4: Indicator for success rate comparison. (from left: failed module, passed module, passed module with insufficient data for comparison)

maximum values. The *Completed Modules* widget sums all modules marked as “passed” in the study plan editor and compares them to the total planned modules. The *Collected ECTS* widget calculates ECTS points from passed modules against the total credits required for graduation. The *Current Semester* widget determines the current semester number based on enrollment data, or defaults to the total number of defined semesters if only historical data exists. The *Open Modules* widget counts modules that are neither passed nor failed, providing a counterpart to the completed modules display. The second row contains two widgets focused on analyzing the study progress. The analytics widget features two bar charts: *Modules per Semester* compares enrolled versus completed modules by semester while calculating averages for both categories, and *ECTS per Semester* presents planned versus achieved ECTS credits by semester with corresponding average calculations. The study planning widget displays the current semester’s planning. It offers direct navigation to the study planner, automatically positioning the scroll bar at the current semester location to ensure students see their academic status immediately. These widgets utilize visual elements such as progress bars and tooltips to enhance usability. They provide students with detailed metrics and quick overviews of their academic progress and planning status. Each module in the study progress display includes a ring visualization (Fig. 4) showing historical success rates of module exams for students in the same nth semester. The ring contains colored segments for students who passed (green), failed (red), or didn’t register for the exam (gray). A center symbol indicates the student’s group, with the relevant segment scaled for emphasis. Gray rings indicate insufficient data for comparison.

Module Recommendations Module recommendations are generated from aggregated datasets provided by the Comparison API. The system removes modules already marked as “passed” by the student, then sorts remaining modules by success rate in descending order. When multiple modules share the same success rate, they are further sorted by enrollment frequency. The top three modules from this list are displayed as recommendations for each future semester. Students can reject displayed recommendations, prompting the system to generate new ones. New recommendations are also calculated when semesters are added to existing study plans. Students can adopt recommendations by clicking on a module, which opens a pre-filtered module catalog. Adding new modules triggers the recalculation of recommendations.

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