

Smart Student-Centric Environments In Higher Education: A Focused Literature Review

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Abstract—Colleges and universities have become increasingly dependent on digital systems for academic records, coursework, communication, assessment, student activities, and institutional services. Yet the presence of multiple digital systems does not necessarily produce a coherent student experience. Students may have access to their grades, course activities, departmental announcements, projects, certifications, and other developmental information, while still having to move between separate platforms to understand their overall progress or determine what they should do next. This paper presents a focused literature review of research on student information systems, digital transformation, learning analytics, student-facing dashboards, e-portfolios, student engagement, and feedback practices in higher education. Twenty-four selected studies from IEEE and other established scholarly venues were examined through a comparative thematic synthesis. The review identifies a recurring shift from institution-centered information management toward student-facing systems that support interpretation, reflection, communication, and action. At the same time, several gaps remain. Information is commonly distributed across independent systems, analytics frequently emphasize measurement rather than subsequent action, and conventional academic records provide only a partial representation of student development. Research on engagement also shows that simple behavioral indicators cannot adequately represent cognitive and emotional dimensions of participation. Based on these findings, this review identifies design considerations for a student-centric departmental environment that can connect academic information, student development, opportunities, communication, and analytics without requiring replacement of existing institutional systems.

Index Terms—higher education, digital transformation, student information systems, student experience, learning analytics, learning dashboards, e-portfolios, student engagement.

I. INTRODUCTION

Every university today operates through an infrastructure of digital systems. Learning management systems handle coursework and instructor communication. Student information systems maintain enrollment, grades, schedules, and academic records. Other platforms are used for examinations, attendance, placements, events, departmental announcements, and student activities. Each system has a defined purpose, and most of these systems have replaced processes that were previously slower or more difficult to manage.

The problem becomes clearer when these systems are considered from the student's perspective. A student attempting to understand their academic and professional development may need to move between an institutional portal for academic records, a learning management system for coursework, communication channels for departmental activities, and another platform for projects, certifications, or achievements. Each source may contain useful information,

but the student is still responsible for assembling the larger picture. Having access to information and being able to use that information effectively are therefore not necessarily the same thing.

This distinction is important in the context of digital transformation. Castro Benavides et al. describe digital transformation in higher education as a multidimensional process involving technology, people, processes, and organizational change rather than the simple introduction of additional software [1]. Similarly, research applying the DeLone and McLean information systems success model to student information systems shows that system quality, information quality, and service quality influence students' perceptions of system usefulness [2]. These findings suggest that digital maturity cannot be evaluated only by counting the number of systems an institution operates.

Learning analytics provides another important part of this discussion. Research has explored the use of educational data for describing student behaviour, predicting performance, identifying patterns, and supporting decision-making [3]-[5].

Student-facing learning analytics dashboards have subsequently attempted to make such information visible to learners themselves [6], [18]. However, the availability of an indicator does not automatically mean that a student understands it or knows what action should follow.

Research on dashboards increasingly reflects this concern. Schwendimann et al. found that learning-dashboard research covers different purposes, data sources, visualization approaches, and levels of evaluation.

Taken together, these areas reveal a common pattern.

Higher education has developed capable systems for individual functions, but these functions often remain disconnected from one another. The resulting problem is therefore not necessarily the absence of information. It is the absence of coherence.

This review examines that problem through five research questions:

RQ1: How do existing digital systems and technologies serve students in higher education?

RQ2: What capabilities of these systems contribute to the student experience?

RQ3: How can information, analytics, dashboards, portfolios, and feedback support action rather than merely provide visibility?

RQ4: What forms of fragmentation and limitation remain across existing approaches?

RQ5: What design considerations emerge for a cohesive, student-focused departmental environment?

The purpose of this review is not to propose another replacement for existing university infrastructure. Instead, it is to identify how useful capabilities from different digital approaches can be connected into a student-centered layer that helps learners understand their current position, recognize opportunities, and determine appropriate next steps.

II. REVIEW METHODOLOGY

1. Review Scope

This study uses a focused literature review rather than a comprehensive systematic review. The intention was to examine literature deeply enough to identify recurring capabilities, limitations, and design patterns relevant to student-centric digital environments rather than to claim exhaustive coverage of every publication in the field.

The review considered peer-reviewed research addressing higher-education information systems, digital transformation, learning analytics, student-facing dashboards, student engagement, feedback, e-portfolios, and

student development. IEEE publications were given particular attention because of their relevance to educational technology and information systems research. Studies from Springer, Elsevier, and other established scholarly venues were also considered where they contributed directly to the review questions.

2. Study Selection

Studies were considered relevant when they addressed higher education and contained a meaningful connection to student-facing digital systems, student information, learning activity, student development, analytics, engagement, or feedback.

The literature was organized into six thematic categories:

- university information systems and digital transformation;
- learning analytics and student-facing dashboards;
- student success and feedback;
- e-portfolios and student development;
- usability and student-centered design; and
- centralized and decentralized digital systems.

3. Data Extraction And Synthesis

For each selected study, the review considered the purpose of the system or intervention, the information or data involved, the intended users, the major capabilities described, and the limitations identified by the authors.

Rather than treating each publication as an isolated contribution, the studies were compared thematically. Particular attention was given to recurring relationships between information visibility, interpretation, student action, engagement, development, and institutional support.

This approach makes it possible to examine a broader question: not simply whether an individual technology works, but how capabilities demonstrated across different technologies could complement one another in a student-centered environment.

The scope of the review is therefore integrative rather than replacement-oriented. Existing student information systems, learning management systems, dashboards, portfolios, and communication systems are treated as components of the existing digital ecosystem. The objective is to understand where a connecting layer could provide additional value

I. Digital Transformation And Higher-Education Information Systems

Digital transformation in higher education has moved beyond the digitization of individual administrative processes. Universities now depend on interconnected technologies for teaching, administration, communication, assessment, student support, and institutional decision-making [1]. However, having multiple digital systems does not

necessarily mean that students experience those systems as a unified environment.

Traditional higher-education information systems are generally organized around institutional functions. Student information systems maintain records such as enrollment, grades, schedules, and course information. Learning management systems support instructional activities and course communication. Separate systems may handle attendance, examinations, placements, events, and other departmental responsibilities. This specialization makes individual systems manageable, but it also creates boundaries between information that may be closely related from a student's perspective.

The importance of information quality is also evident in student information systems. Çelik and Ayaz found that system quality, information quality, and service quality contribute to students' perceptions of system success [2]. This reinforces an important design principle for student-centric environments: information becomes useful only when students can access it reliably and understand its relevance.

Several IEEE studies further demonstrate the variety of approaches used to manage student information and learning activity. Chen and Zhang describe a web-based student information management system that centralizes student-related information and services [24]. While such systems demonstrate the value of structured information management, centralization alone does not resolve the

broader issue of connecting academic information with developmental activities, opportunities, feedback, and student-facing analytics.

The same distinction appears in learning systems. Learning management systems can capture substantial information about student interaction, but that information may remain within the boundaries of individual courses. Owatari et al., for example, explored a real-time learning analytics dashboard for students in online classes, demonstrating how activity information can be presented directly to learners [20]. Similarly, Cechinel et al. developed a Moodle-based dashboard using machine-learning techniques to identify students at risk of failure, showing how learning-management data can be transformed into information for earlier support [21].

This creates an opportunity for a different form of integration. Rather than replacing institutional systems or moving all information into a new central database, a student-centric layer could selectively connect information that benefits from being viewed together. Academic records could remain within the institutional system, coursework within the LMS, and departmental activities within their existing services, while a student-facing environment provides a coherent view of relevant information and directs students back to the appropriate source.

Such an approach also reduces the risk of creating another institutional silo. The objective is not to centralize everything. It is to make important relationships between existing information visible to the student.

Approach	Academic	Analytics	Development	Communication	Limitation
SIS	✓	—	—	—	Fragmented
LMS	✓	✓	—	✓	Course-bound
Dashboard	✓	✓	—	—	Metric-focused
E-Portfolio	—	—	✓	—	Often isolated
Department Platform	✓	—	✓	✓	Limited integration

4. Learning Analytics And Student-Facing Dashboards

Learning analytics is important to a student-centric environment because digital learning activities generate information that can potentially reveal patterns not visible in conventional academic records. Research has examined descriptive analytics, predictive models, behavioral indicators, and visualization approaches for understanding student learning [3][5].

The central challenge, however, is not whether data can be collected. Modern educational systems can collect considerable amounts of it. The more difficult question is whether the resulting information helps students understand their situation and make better decisions.

Ifenthaler and Yau's systematic review examined the use of learning analytics to support study success and identified both opportunities and limitations in translating analytics

into educational support [4]. Guzmán-Valenzuela et al. similarly identified a strong emphasis on analytics within the literature relative to evidence concerning actual learning [5]. These findings suggest that analytical sophistication should not be confused with educational usefulness.

Student-facing dashboards emerged partly in response to this issue. Instead of restricting analytics to administrators, dashboards make selected information visible to learners.

Bodily and Verbert's review showed substantial variation among student-facing dashboards in terms of data sources, functionality, design, and evaluation [6]. Schwendimann et al. reached a related conclusion in their systematic review, noting that dashboard research was still characterized by considerable exploratory and proof-of-concept work and calling for stronger longitudinal evaluation [18].

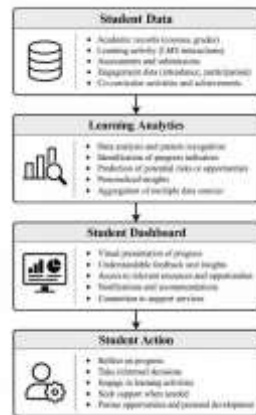


Fig: Conceptual flow from student data to analytics-informed student

support.

This variation is significant. There is no universal dashboard configuration that can be applied to every institution or student population. A useful dashboard must select information according to the decisions students are expected to make.

Recent research also shows increasing interest in machine learning within learning analytics dashboards. Perać et al.'s systematic review identifies performance prediction and the identification of at-risk students as common applications, while also noting challenges related to sample size, algorithm selection, and evaluation [22].

This is useful for a student-centric environment, but it also reinforces the need to treat prediction carefully. A prediction is not itself an intervention. Balaban et al. examined the use of learning analytics dashboards to monitor student progress in a blended computer science course [23]. Such course-level dashboards demonstrate the usefulness of progress visibility, but a broader student environment may require information beyond individual course activity, including projects, certifications, extracurricular participation, and career-oriented opportunities.

The distinction between information and action is therefore critical. A dashboard may tell a student that their activity has decreased, that their performance is below a particular threshold, or that they are at elevated risk. The student still needs to understand why the indicator matters and what reasonable action is available. Susnjak et al. explicitly frame

learning analytics dashboards around actionable insights rather than analytics alone [16]. Alalawi et al. provide further evidence that interventions linked to predictive information can produce different outcomes from simply presenting predicted performance [17]. The implication is straightforward: the output of analytics should ideally connect to an appropriate next step.

A student-centric environment should therefore use analytics as one component of a broader student profile rather than as the definition of the student. Academic indicators can be complemented by projects, certifications, competitions, internships, extracurricular activities, self-reported goals, and other forms of development. The purpose is not to produce a single score that ranks students. It is to provide a more useful picture of where a student currently stands and what opportunities or support may be relevant.

2.5 Student Engagement , Feedback & Continuous

Support

Academic records provide necessary information about students, but they do not represent the entirety of student development. A student's learning journey also includes practical projects, internships, certifications, competitions, extracurricular participation, personal reflection, and other experiences that may not appear in formal academic records.

E-portfolios have emerged as one approach to capturing these dimensions. Beckers et al.'s systematic review indicates that e-portfolios can support self-directed learning when they incorporate elements such as goal setting, self-assessment, guidance, and meaningful integration with learning activities [9]. López-Crespo et al. provide additional evidence linking educational e-portfolio activity with self-efficacy and engagement [10]. In software engineering education, Macías demonstrated how an e-portfolio approach could support project-based laboratory work and provide a richer representation of student activity than conventional grading alone [11].

The same issue appears when considering student engagement. Engagement is often tempting to represent through simple behavioral indicators such as logins, clicks, activity frequency, or time spent on a platform. However, these measures describe observable behavior rather than engagement in its entirety.

Bergdahl et al.'s systematic review of higher-education learning analytics research demonstrates that student engagement is multidimensional and includes behavioral, cognitive, and emotional dimensions [13]. Silvola et al. further examine expectations surrounding the use of learning analytics to support student engagement across the academic path [14]. These studies suggest that engagement should be interpreted cautiously rather than reduced to a single numerical value.

Feedback provides another link between information and action. Information tells a student what exists or where they currently stand; feedback helps them understand what to do

with that information. Banihashem et al.'s systematic review highlights the role of learning analytics in supporting feedback practices in higher education [15]. The value of feedback, however, depends on whether students can understand and use it.

An effective feedback cycle can therefore be represented as:

6. Information → Interpretation → Action →

Reassessment

For example, a student may identify that a required skill is underdeveloped, receive an explanation of the relevant evidence, discover a workshop or learning resource related to that skill, participate in the activity, and later review their progress. The same pattern can apply to academic performance, project development, certifications, or extracurricular goals.

Most importantly, the system should avoid converting student development into a single score. Academic performance, projects, awards, certifications, activities, and self-reported goals represent different dimensions of development. Combining them into one ranking may make the interface appear simpler while removing the very context that makes the information useful.

The purpose of student-centric integration should therefore be **understanding rather than scoring**.

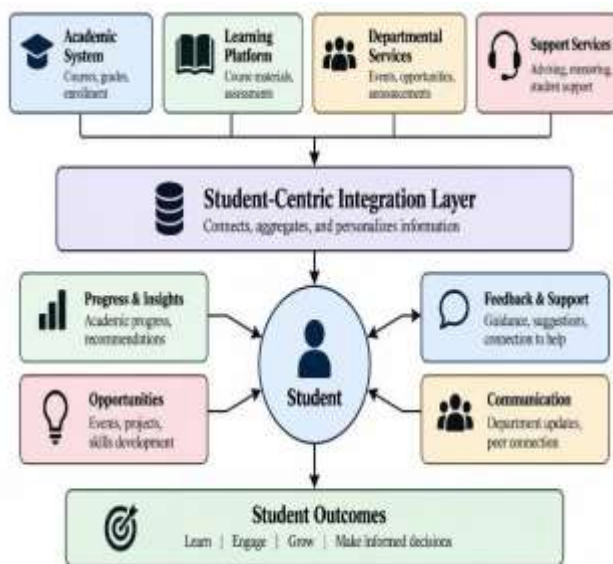


Fig: Conceptual model for an integrated student-centric departmental environment

III. RESEARCH GAPS AND DESIGN CONSIDERATIONS

The literature reviewed in this study does not suggest that higher education lacks useful digital technologies. Instead, it reveals that many useful capabilities have developed independently. Student information systems manage formal records, learning management systems manage course activity, analytics systems analyze behavior, dashboards visualize selected indicators, and e-portfolios capture broader development.

1. The Major Opportunity Lies In Connecting These Capabilities Without Unnecessarily Replacing Them.

a. Fragmentation Of Information

The most consistent gap is fragmentation. Academic records, learning activity, departmental events, student development information, and support resources may exist in separate systems. The literature on digital transformation shows that successful transformation involves more than technological deployment [1]. A student-centric approach

should therefore avoid assuming that another standalone application will solve the problem.

b. Analytics-To-Action Gap

Learning analytics can identify patterns, predict performance, and surface indicators [3]-[5], but an indicator does not automatically produce action. Research on dashboards increasingly emphasizes learner-centered presentation, interpretation, and actionable insight [6], [7], [16], [18]. The design opportunity is therefore to connect analytical outputs with contextual next steps. For example, an indicator related to weak performance could be accompanied by an explanation, relevant learning resources, available faculty support, or an upcoming workshop. Such recommendations should remain contextual rather than prescriptive.

2. Incomplete Representation Of Student Development

Formal academic systems primarily represent institutional milestones such as enrollment, courses, grades, and completion. E-portfolios demonstrate that students can also benefit from representing projects, reflection, skills, and other developmental evidence [9]-[11]. A student-centric environment should therefore provide a broader student profile containing academic information alongside appropriate developmental records. This profile should distinguish verified institutional information from student-submitted information rather than treating every entry as equally authoritative.

3. Limitations Of Engagement Measurement

Engagement cannot reliably be reduced to login frequency, clicks, or time spent online. Research identifies behavioural, cognitive, and emotional dimensions of engagement [13], while expectations for analytics-based engagement support vary across the academic journey [14]. Accordingly, engagement indicators should be presented as signals rather than definitive judgments. A student-centric system should avoid labels such as “low engagement” when the underlying evidence only represents limited platform activity.

4. Explainability And Student Trust

The increasing use of predictive and machine-learning approaches creates another design concern. Peraić et al. show that machine learning is increasingly used within learning analytics dashboards for prediction and identification of at-risk students [22].

However, predictive output is meaningful to students only when they can understand its context and limitations. Students should be able to determine what an indicator measures, what information contributed to it, and why it has been presented. Where predictions are uncertain, that uncertainty should not be hidden behind a precise-looking score.

5. Selective Rather Than Total Integration

Integration should not mean collecting every available student data point into one system. Such an approach can increase complexity and create unnecessary privacy and governance concerns. Instead, integration should be **purpose-driven and selective**.

Information should be connected when the relationship provides clear value to students, faculty, or advisors. Existing systems should remain the authoritative source for information they are responsible for maintaining.

This produces a different model from traditional

centralization:

6. Existing Systems → Selective Integration → Student Context → Interpretation → Action

The integration layer becomes a means of reducing fragmentation rather than another destination where all institutional data must be stored.

Research gap	Limitation identified in literature	Design consideration
Information fragmentation	Relevant student information is distributed across systems	Provide a unified student-facing integration layer
Analytics-to-action gap	Indicators may not explain what students should do next	Connect insights with contextual resources and actions
Limited development records	Formal academic records capture only part of student development	Support broader profiles containing projects, skills, certifications, and activities
Engagement measurement	Behavioral indicators do not fully represent engagement	Treat engagement as multidimensional and contextual
Predictive analytics	Predictions may be difficult for students to interpret	Provide explanations, context, and appropriate uncertainty
Communication fragmentation	Opportunities and departmental information may be distributed across channels	Provide a consolidated, relevant opportunity and information feed
Integration complexity	Full centralization can duplicate or replace existing systems	Use selective, context-aware integration

7. Conceptual Design Framework

Based on the reviewed literature, a student-centric departmental environment can be understood as five connected layers.

8. Student Profile Layer:

Academic identity, skills, projects, certifications, achievements, activities, interests, and selected developmental information.

9. Academic Information Layer:

Relevant academic records, course progress, assessments, learning activity, and other information obtained from existing institutional systems.

Opportunity and Communication Layer: Departmental events, workshops, competitions, internships, clubs, placement activities, announcements, and relevant learning opportunities.

IV. ANALYTICS AND SUPPORT LAYER:

Descriptive indicators, progress visualization, carefully selected predictive insights, feedback, recommendations, and support pathways.

1. Integration and Governance Layer: Authentication, data-source connections, permissions, provenance, privacy, access control, and mechanisms for keeping connected information reliable.

V. CONCLUSION

The literature reviewed in this study suggests that the central challenge is therefore not a lack of digital capability. It is a lack of coherence between capabilities that already exist.

Across the reviewed studies, three issues appear repeatedly. First, student information remains distributed across systems designed around different institutional functions. Second, analytics can provide useful indicators without necessarily explaining what students should do next. Third, conventional academic records do not fully represent the broader development of students through projects, certifications, competitions, internships, activities, and other experiences.

The findings also indicate that solving these problems does not require replacing every existing university system. A more practical approach is to create a student-facing integration layer that selectively connects relevant information while preserving existing systems as authoritative sources. Within such an environment, analytics can support interpretation rather than simply measurement, e-portfolios can complement formal academic records, communication can improve opportunity visibility, and feedback can connect information to action.

A student-centric environment should consequently be evaluated not by how much data it collects or how many features it contains, but by whether students can use it to answer practical questions: **Where am I? What have I accomplished? What needs attention? What opportunities are relevant to me? And what can I do next?**

Future research should move beyond isolated prototypes and short-term evaluations toward longitudinal studies of integrated student environments in authentic institutional settings. Such research should examine usability, student engagement, learning outcomes, decision-making, privacy, explainability, and the effects of connecting multiple dimensions of student development. The goal is not to create another disconnected digital platform, but to make the digital environment students already use more coherent, understandable, and useful.

REFERENCES

1. L. M. Castro Benavides, J. A. Tamayo Arias, M. D. Arango Serna, J. W. Branch Bedoya, and D. Burgos, "Digital Transformation in Higher Education Institutions: A Systematic Literature Review," *Sensors*, vol. 20, no. 11, Art. no. 3291, 2020, doi: 10.3390/s20113291.
2. K. Çelik and A. Ayaz, "Validation of the DeLone and McLean Information Systems Success Model: A Study on Student Information System," *Education and Information Technologies*, vol. 27, no. 4, pp. 4709–4727, 2022, doi: 10.1007/s10639-021-10798-4.
3. H. Aldowah, H. Al-Samarraie, and W. M. Fauzy, "Educational Data Mining and Learning Analytics for 21st Century Higher Education: A Review and Synthesis," *Telematics and Informatics*, vol. 37, pp. 13–49, 2019, doi: 10.1016/j.tele.2019.01.007.
4. D. Ifenthaler and J. Y.-K. Yau, "Utilising Learning Analytics to Support Study Success in Higher Education: A Systematic Review," *Educational Technology Research and Development*, vol. 68, pp. 1961–1990, 2020, doi: 10.1007/s11423-020-09788-z.
5. C. Guzmán-Valenzuela, C. Gómez-González, A. Rojas-Murphy Tagle, and A. Lorca-Vyhmeister, "Learning analytics in higher education: A preponderance of analytics but very little learning?," *International Journal of Educational Technology in Higher Education*, vol. 18, Art. no. 23, 2021, doi: 10.1186/s41239-021-00258-x.
6. R. G. Bodily and K. Verbert, "Review of Research on Student-Facing Learning Analytics Dashboards and Educational Recommender Systems," *IEEE Transactions on Learning Technologies*, vol. 10, no. 4, pp. 405–418, 2017, doi: 10.1109/TLT.2017.2740172.
7. L. Paulsen and E. Lindsay, "Learning analytics dashboards are increasingly becoming about learning and not just analytics- A systematic review," *Education*

- and Information Technologies, vol. 29, pp. 14279–14308, 2024, doi: 10.1007/s10639-023-12401-4.
8. S. Charleer, A. Vande Moere, J. Klerkx, K. Verbert, and T. De Laet, “Learning Analytics Dashboards to Support Adviser-Student Dialogue,” *IEEE Transactions on Learning Technologies*, vol. 11, no. 3, pp. 389–399, 2018, doi: 10.1109/TLT.2017.2720670.
9. J. Beckers, D. Dolmans, and J. van Merriënboer, “E-Portfolios Enhancing Students’ Self-Directed Learning: A Systematic Review of Influencing Factors,” *Australasian Journal of Educational Technology*, vol. 32, no. 2, pp. 32–46, 2016, doi: 10.14742/ajet.2528.
10. G. López-Crespo, M. C. Blanco-Gandía, S. Valdivia-Salas, C. Fidalgo, and N. Sánchez-Pérez, “The Educational e-Portfolio: Preliminary Evidence of Its Relationship with Student’s Self-Efficacy and Engagement,” *Education and Information Technologies*, vol. 27, no. 4, pp. 5233–5248, 2022, doi: 10.1007/s10639-021-10827-2.
11. J. A. Macías, “Enhancing Project-Based Learning in Software Engineering Lab Teaching Through an E-Portfolio Approach,” *IEEE Transactions on Education*, vol. 55, no. 4, pp. 502–507, Nov. 2012.
12. A. Pardo, F. Han, and R. A. Ellis, “Combining University Student Self-Regulated Learning Indicators and Engagement with Online Learning Events to Predict Academic Performance,” *IEEE Transactions on Learning Technologies*, vol. 10, no. 1, pp. 82–92, 2017, doi: 10.1109/TLT.2016.2639508.
13. N. Bergdahl, M. Bond, J. Sjöberg, M. Dougherty, and E. Oxley, “Unpacking Student Engagement in Higher Education Learning Analytics: A Systematic Review,” *International Journal of Educational Technology in Higher Education*, vol. 21, Art. no. 63, 2024, doi: 10.1186/s41239-024-00493-y.
14. A. Silvola, P. Näykki, A. Kaveri, and H. Muukkonen, “Expectations for Supporting Student Engagement with Learning Analytics: An Academic Path Perspective,” *Computers & Education*, vol. 168, Art. no. 104192, 2021, doi: 10.1016/j.compedu.2021.104192.
15. S. K. Banihashem, O. Noroozi, S. van Ginkel, L. P. Macfadyen, and H. J. A. Biemans, “A Systematic Review of the Role of Learning Analytics in Enhancing Feedback Practices in Higher Education,” *Educational Research Review*, vol. 37, Art. no. 100489, 2022, doi: 10.1016/j.edurev.2022.100489.
16. T. Susnjak, G. S. Ramaswami, and A. Mathrani, “Learning Analytics Dashboard: A Tool for Providing Actionable Insights to Learners,” *International Journal of Educational Technology in Higher Education*, vol. 19, Art. no. 12, 2022, doi: 10.1186/s41239-021-00313-7.
17. K. Alalawi, R. Athauda, R. Chiong, and I. Renner, “Evaluating the Student Performance Prediction and Action Framework Through a Learning Analytics Intervention Study,” *Education and Information Technologies*, vol. 30, pp. 2887–2916, 2025, doi: 10.1007/s10639-024-12923-5.
18. B. A. Schwendimann, M. J. Rodríguez-Triana, A. Vozniuk, L. P. Prieto, M. Shirvani Boroujeni, A. Holzer, D. Gillet, and P. Dillenbourg, “Perceiving Learning at a Glance: A Systematic Literature Review of Learning Dashboard Research,” *IEEE Transactions on Learning Technologies*, vol. 10, no. 1, pp. 30–41, 2017, doi: 10.1109/TLT.2016.2599522.
19. K. Mangaroska and M. Giannakos, “Learning Analytics for Learning Design: A Systematic Literature Review of Analytics-Driven Design to Enhance Learning,” *IEEE Transactions on Learning Technologies*, vol. 12, no. 4, pp. 516–534, 2019, doi: 10.1109/TLT.2018.2868673.
20. T. Owatari, A. Shimada, T. Minematsu, M. Hori, and R. I. Taniguchi, “Real-Time Learning Analytics Dashboard for Students in Online Classes,” in *Proc. 2020 IEEE TALE*, pp. 523–529, 2020, doi: 10.1109/TALE48869.2020.9368340.
21. C. Cechinel, M. de Freitas dos Santos, C. Barrozo, J. E. Schardosim, E. de Vila, V. Ramos, T. Primo, R. Munoz, and E. M. Queiroga, “A Learning Analytics Dashboard for Moodle: Implementing Machine Learning Techniques to Early Detect Students at Risk of Failure,” in *Proc. 2021 XVI Latin American Conference on Learning Technologies (LACLO)*, 2021, doi: 10.1109/LACLO54177.2021.00019.
22. I. Peraić, A. Grubišić, and N. Pintarić, “Machine Learning in Learning Analytics Dashboards: A Systematic Literature Review,” in *Proc. 2025 IEEE 23rd World Symposium on Applied Machine Intelligence and Informatics (SAMI)*, pp. 47–52, 2025, doi: 10.1109/SAMI63904.2025.10883302.
23. I. Balaban, M. Zlatovic, and M. Matus, “Using Learning Analytics Dashboards to Monitor Student Progress: The Case of a Blended Computer Science University Course,” in *Proc. 2024 IEEE International Conference on Advanced Learning Technologies (ICALT)*, pp. 72–74, 2024, doi: 10.1109/ICALT61570.2024.00027.
24. M. Chen and Y. Zhang, “Design and Implementation of Student Information Management System based on Web,” in *Proc. 2022 International Conference on Computers, Information Processing and Advanced Education (CIPAE)*, 2022, doi: 10.1109/CIPAE55637.2022.00020.