# A Rule-Based Digital Assessment Framework for Evaluating Students' Digital Literacy and Safe Cybersocialization in Higher Education

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Abstract: Digital literacy has become a critical condition for effective learning, safe online interaction, and responsible participation in digital society. However, many existing studies remain descriptive and do not provide an applied information-technology instrument for evaluating students' digital behavior in educational settings. This study proposes a rule-based digital assessment framework for measuring students' digital literacy and safe cybersocialization in higher education. The framework transforms survey-based and qualitative indicators into a structured multi-criteria model including four analytical dimensions: digital learning engagement, perceived quality of the educational environment, acceptance of digital teaching methods, and awareness of online behavioral risks. The empirical basis of the study includes survey data from 500 respondents on Internet use patterns and a focused assessment of 146 university students using a modified questionnaire and essay-based qualitative analysis. On the basis of these data, a scoring logic and decision-support structure are formulated to classify learners into low-, medium-, and high-readiness groups and to generate targeted educational recommendations. The proposed framework contributes an applied IT-oriented model that bridges educational diagnostics and digital decision support. The results show that the collected indicators can be formalized into an interpretable assessment structure suitable for prototype implementation in university digital platforms.

## 1 INTRODUCTION

The rapid expansion of digital technologies has significantly transformed higher education, creating new opportunities for communication, learning, and access to information. In Uzbekistan, the national digital transformation agenda has further emphasized the importance of integrating digital tools and competencies into education and public life [1]. At the same time, the modernization of higher education increasingly requires quality-oriented approaches that support effective learning in digitally mediated environments [2]. As a result, digital literacy has become a key condition for successful academic participation and sustainable educational development [3], [4]. Broader analytical reports on Internet development also indicate that digital engagement has become a stable structural characteristic of contemporary society, which increasingly influences educational practices and patterns of online participation [5].

Digitalization has also changed the social experience of students. Social networks, online platforms, and virtual communication environments influence the formation of digital culture, digital identity, and new patterns of interaction [6], [7]. These processes extend beyond technical skills and include information evaluation, online communication, responsible behavior, and the ability to navigate risks associated with digital environments. From a broader sociological perspective, individual socialization increasingly unfolds under the dynamic influence of information and communication technologies, which reshape interaction patterns, identity formation, and

behavioral adaptation in digital environments [8]. Previous studies have shown that digital literacy is closely related to students' online participation and may affect their exposure to online risk and the overall quality of digital engagement [9], [10].

Despite the growing body of research on digital literacy and socialization, many existing studies remain descriptive and focus primarily on pedagogical or sociological interpretation. While such studies provide valuable conceptual insights, they often do not offer an applied information-technology mechanism for structured assessment in higher education settings [3], [6], [7]. In practice, universities need interpretable tools that can transform students' responses, behavioral indicators, and qualitative feedback into a formalized assessment structure suitable for monitoring and decision support.

Therefore, this study proposes a rule-based digital assessment framework for evaluating students' digital literacy and safe cybersocialization in higher education. The proposed approach converts survey-based and qualitative indicators into a structured analytical model for identifying students' digital readiness, awareness of online risks, and acceptance of digital educational practices. In this sense, the study follows the broader logic of applied IT research, where computational models are used to formalize complex real-world processes and support interpretable analytical solutions [11]. The novelty of the study lies in transforming descriptive educational and behavioral evidence into an applied rule-based digital assessment framework that supports structured evaluation of students' digital literacy and safe cybersocialization in higher education. The aim of the study is to develop an applied framework that can serve as a basis for further implementation in university digital environments.

The main contribution of this study is not limited to describing students' attitudes toward digital education. Instead, the paper proposes an applied rule-based assessment framework that formalizes heterogeneous educational and behavioral evidence into a reproducible decision-support structure. In particular, the study contributes: (1) a four-component analytical model integrating content-related, environmental, digital-method, and risk-awareness dimensions; (2) a transparent scoring and classification logic for assigning students to digital readiness groups; and (3) a prototype-oriented computational workflow that can be integrated into university digital platforms for monitoring and targeted educational intervention.

# 2 MATERIALS AND METHODS

The empirical basis of the study consisted of quantitative and qualitative data describing students' attitudes toward the digitalization of education and their perceptions of the educational environment. The study involved 146 students and undergraduates in various fields of study. Data collection was carried out using two complementary instruments: a modified questionnaire entitled *Satisfaction with education using digital resources* and a phenomenological analysis of student essays on the topic *My attitude to the digitalization of education*. This combination made it possible to capture both structured evaluative responses and deeper qualitative reflections on students' digital educational experience.

The study used two datasets with different roles: generalized Internet-use data from 500 respondents provided contextual background, whereas the DLSCI framework, scoring logic, and classification procedure were developed only from the focused sample of 146 university students and undergraduates. Accordingly, the study is presented as a pilot applied framework rather than a population-level generalization.

The quantitative component of the study was designed to assess students' perceptions of the educational process in a digitally mediated environment. The questionnaire data were grouped into four analytical dimensions: satisfaction with the content of education, satisfaction with educational conditions, satisfaction with traditional teaching methods, and satisfaction with digital teaching methods. Such grouping made it possible to interpret students' responses not only as isolated opinions, but also as formalized indicator sets reflecting their acceptance of educational digitalization and their readiness for participation in digital learning processes [2]-[4].

Satisfaction with traditional teaching methods was used as a comparative contextual indicator and was not included as a standalone component of the DLSCI; instead, it served to interpret students' relative acceptance of digitally mediated instruction.

The qualitative component was based on phenomenological text analysis of students' essays. The purpose of this stage was to identify semantic units reflecting both positive and negative effects of digitalization in education. The analysis revealed several recurring themes, including extensive learning opportunities, accessibility of educational materials, flexibility of time management, reduced anxiety, decreased physical and social activity, fear of

direct interpersonal communication, and signs of digital fatigue. These themes were further generalized into two broader categories: positive effects of digitalization of education and negative effects of digitalization of education. This procedure made it possible to include not only satisfaction indicators, but also risk-related and behavioral factors in the analytical structure of the study [6], [7], [9], [10].

The risk-awareness score was derived from coded essay themes related to communication anxiety, reduced physical activity, digital fatigue, and dependence on digitally mediated learning. Essays were segmented into meaning units, grouped into recurring themes, and aggregated into broader positive and risk-related categories. These coded themes informed the risk-awareness component of the DLSCI, allowing qualitative evidence to be used as a structured analytical input rather than as descriptive narrative.

To align the study with an applied IT perspective, the collected evidence was formalized into a rule-based digital assessment framework. In this framework, questionnaire and qualitative indicators are treated as structured input variables for analytical interpretation. Four core components were used in the assessment logic: content-related score, educational environment score, digital methods acceptance score, and risk-awareness score. Their aggregated interaction forms the basis of a composite indicator referred to as the Digital Literacy and Safe Cybersocialization Index.

In generalized form, the proposed index can be expressed as

$$DLSCI = w_1C + w_2E + w_3D + w_4R, \quad (1)$$

where $C$ is the content-related score, $E$ is the educational environment score, $D$ is the digital methods acceptance score, $R$ is the risk-awareness score derived from qualitative and survey evidence, and $w_1$–$w_4$ are weighting coefficients assigned to the corresponding components. For computational implementation, each questionnaire response category was transformed into a numerical score on a 0-100 scale. The response “Everything is fine, no changes needed” was assigned the highest score, “Overall good but could be improved” a moderately high score, “Improvements needed” a lower score, and “Everything needs to change” the lowest score. For each analytical dimension, the corresponding item scores were aggregated and normalized to a common 0-100 range in order to ensure comparability across components. This normalization made it possible to combine heterogeneous indicators into the composite DLSCI structure without scale imbalance. The use of a weighted structure is consistent with applied digital assessment approaches in which heterogeneous educational and behavioral indicators are transformed into interpretable composite measures [3], [11].

The weighting coefficients in the pilot version of the model were assigned by expert-informed heuristic reasoning based on the interpretive importance of the extracted dimensions for digital readiness assessment in higher education. Greater weights were assigned to the content-related score ($w_1$=0.35) and the digital methods acceptance score ($w_3$=0.30), because these dimensions reflect the student’s direct interaction with digitally mediated learning. The educational environment score ($w_2$=0.20) was treated as a supporting institutional factor, while the risk-awareness score ($w_4$=0.15) was incorporated as a balancing psychosocial component. This weighting structure should be understood as a pilot analytical configuration that prioritizes interpretability and prototype feasibility rather than statistical optimization.

Future work may include data-driven optimization of weighting coefficients using statistical or machine learning techniques.

To demonstrate the practical applicability of the proposed analytical model, a prototype algorithmic solution was developed. Listing 1 presents the core logic of the decision-support module, written in Python, which calculates the Digital Literacy and Safe Cybersocialization Index (DLSCI) by applying predefined weighting coefficients to the four extracted assessment dimensions. This lightweight computational script automatically classifies students into appropriate digital readiness groups, enabling seamless integration into existing university learning management systems (LMS) or monitoring dashboards for data-driven educational interventions.

Listing 1. Python implementation of the DLSCI scoring and classification logic

```
  def assess_digital_readiness(c, e, d,
r):
      dlsci = 0.35*c + 0.20*e + 0.30*d
+ 0.15*r
      if dlsci >= 75:
          level    =    "High    Digital
Readiness"
      elif dlsci >= 50:
          level  =  "Moderate  Digital
Readiness"
      else:
          level    =    "Low    Digital
Readiness"
      return round(dlsci, 2), level
```

Listing 1 presents a compact Python implementation of the DLSCI scoring and classification logic for prototype integration into LMS or dashboard environments.

Based on the aggregated score, students may be classified into three analytical categories: low digital readiness, moderate digital readiness, and high digital readiness. This classification is intended to support decision-oriented interpretation rather than merely descriptive reporting. In practical terms, such a structure can be used as the basis for prototype implementation in a university digital platform, dashboard, or internal monitoring system aimed at evaluating students' digital literacy and identifying areas requiring pedagogical or preventive intervention [3], [9], [11].

To verify reproducibility, the weighted DLSCI model was compared with a simple unweighted-average baseline using representative low-, moderate-, and high-readiness profiles. The weighted model produced scores of 33.0, 64.0, and 84.0, while the baseline yielded 32.5, 62.5, and 82.5; in all cases the qualitative classes remained consistent. A limited sensitivity checks around weights and thresholds did not change the interpretation of these profiles, indicating adequate pilot stability and transparent rule-based behavior.

# 3 PROPOSED DIGITAL ASSESSMENT FRAMEWORK

The proposed digital assessment framework is designed to transform descriptive educational and behavioral evidence into a structured decision-support model for evaluating students' digital literacy and safe cybersocialization. The framework includes five sequential layers. The first layer is the data acquisition layer, which collects questionnaire responses and qualitative textual reflections from students. The second layer is the indicator extraction layer, where the collected data are grouped into measurable analytical dimensions, including satisfaction with educational content, satisfaction with educational conditions, acceptance of digital teaching methods, and awareness of risks associated with digital educational experience. The third layer is the rule-based scoring layer, in which each dimension is converted into a normalized score. The fourth layer is the classification layer, where the aggregated results are interpreted to identify different levels of digital readiness. The fifth layer is the recommendation layer, which generates decision-oriented outputs for improving students' digital literacy and safe online behavior.

The practical logic of the framework is based on the assumption that positive perceptions of digital education do not automatically mean the absence of risks. For this reason, the model combines both positive educational indicators and risk-related qualitative indicators. The questionnaire results provide structured evidence of students' satisfaction with content, conditions, and teaching methods, whereas essay analysis reveals deeper psychosocial effects of digitalization, such as reduced anxiety, improved access to learning materials, and better time flexibility, as well as negative outcomes such as lower physical activity, fear of direct communication, and digital fatigue. In this way, the framework formalizes both acceptance-related and risk-related aspects of students' digital educational experience.

In applied terms, the proposed framework can be integrated into a university digital platform, internal monitoring dashboard, or decision-support module. Its main advantage is interpretability: instead of relying on a black-box model, the framework uses transparent analytical dimensions and explicit rule-based logic. This makes the approach suitable for pilot implementation in higher education institutions that need explainable tools for monitoring digital readiness and identifying areas requiring educational intervention. The framework also responds directly to the need for an applied IT-oriented contribution by introducing a formalized analytical structure rather than a purely descriptive account of student attitudes. This approach is consistent with applied IT studies in which computational logic is used to structure complex real-world educational processes [3], [11].

The general logic of the proposed framework is illustrated in Figure 1. It demonstrates how quantitative and qualitative student data are transformed into a structured rule-based model for digital readiness assessment and recommendation generation. As shown in Figure 1, the framework integrates data collection, indicator formalization, scoring, classification, and recommendation output into a single analytical structure. This architecture supports the practical implementation of the proposed approach in higher education digital systems.

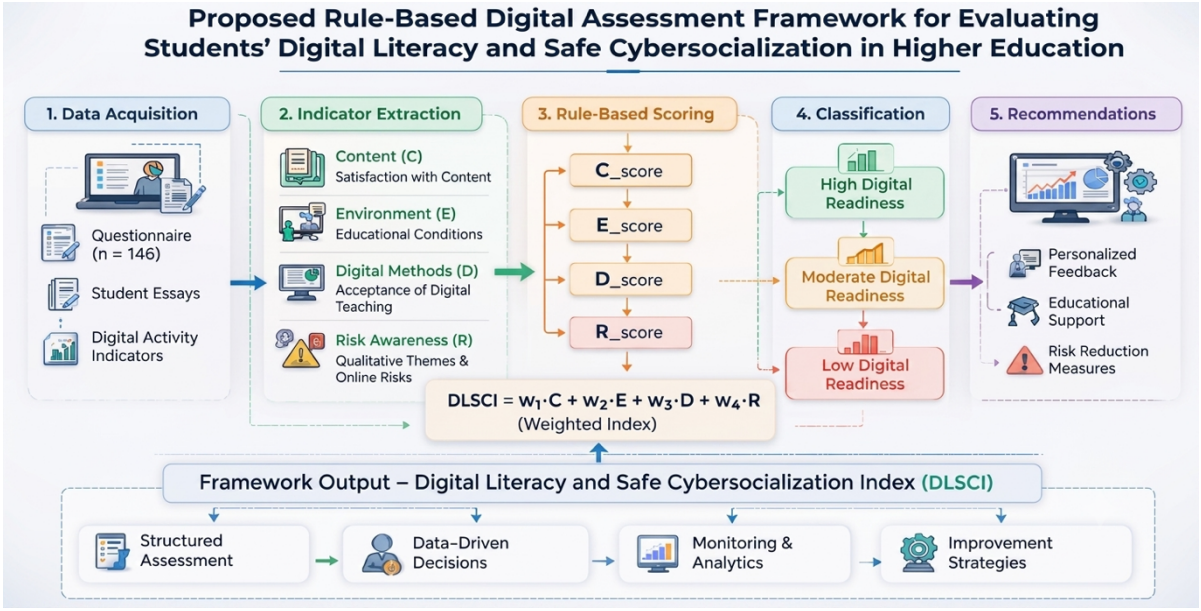


Figure 1: Architecture of the proposed rule-based digital assessment framework for evaluating students' digital literacy and safe cybersocialization in higher education.

The proposed framework converts questionnaire and essay data into a five-stage decision-support pipeline: data acquisition, indicator extraction, normalized scoring, readiness classification, and recommendation generation. It combines acceptance-related indicators with risk-related qualitative evidence so that positive perceptions of digital education are not interpreted as the absence of psychosocial risk.

In applied terms, the framework can be implemented as a lightweight LMS or dashboard module. Student inputs are transformed into component scores, aggregated into the DLSCI, and mapped to readiness levels with corresponding intervention recommendations for students, instructors, and administrators. Figure 1 summarizes this explainable rule-based workflow.

# 4 RESULTS

The quantitative results indicate that students generally perceive the digitalization of education positively. In relation to the content of education, 5.09% of respondents reported that no changes were needed, while 75.34% evaluated the content as generally good but improvable. Thus, 80.43% of responses reflected a positive or conditionally positive attitude toward the educational content, whereas only 19.57% indicated substantial dissatisfaction. These findings suggest that the content-related component of digital educational experience can be interpreted as a relatively strong input dimension in the proposed framework. As shown in Table 1, most students evaluated the content of education positively, although many respondents indicated that further improvement is still needed.

Table 1: Satisfaction with the content of education.

| Answer options | Number of responses in % |
|---|---|
| Everything is fine, no changes needed | 5.09 |
| Overall good but could be improved | 75.34 |
| Improvements needed | 17.52 |
| Everything needs to change | 2.05 |

A similarly positive tendency was observed in the assessment of educational conditions. According to Table 2, 21.92% of respondents considered the educational conditions fully satisfactory, and 47.95% assessed them as generally good but requiring improvement. In total, 69.87% of students expressed a favorable assessment of the educational environment, while 30.13% pointed to the need for improvement or change. These results indicate that students accept the general educational setting, although the environment-related dimension remains less stable than the content-related one and therefore requires institutional attention in further digital

transformation efforts. Table 2 presents students' evaluation of the educational conditions, including the material, technical, personnel, and classroom environment.

Table 2: Satisfaction with the conditions of education.

| Answer options | Number of responses in % |
|---|---|
| Everything is fine, no changes needed | 21.92 |
| Overall good but could be improved | 47.95 |
| Improvements needed | 28.08 |
| Everything needs to change | 2.05 |

The evaluation of teaching methods also demonstrated a generally positive pattern. For traditional teaching methods, 17.8% of respondents indicated complete satisfaction and 51.37% reported that the methods were generally good but could be improved. This means that 69.17% of students assessed traditional teaching methods positively, while 30.83% expressed dissatisfaction to some degree. In contrast, digital teaching methods received a somewhat stronger evaluation: 15.75% of respondents considered them fully satisfactory and 58.9% assessed them positively with minor reservations. As a result, 74.65% of responses reflected favorable acceptance of digital teaching methods, while 25.35% pointed to the need for improvement. These data suggest that digital methods are perceived slightly more positively than traditional ones, which strengthens the argument for integrating digitally supported educational solutions into higher education practice. As shown in Table 3, students generally rated traditional teaching methods positively, although a notable proportion of respondents indicated the need for improvement.

Table 3: Satisfaction with traditional teaching methods.

| Answer options | Number of responses in % |
|---|---|
| Everything is fine, no changes needed | 17.8 |
| Overall good but could be improved | 51.37 |
| Improvements needed | 30.15 |
| Everything needs to change | 0.68 |

Table 4 demonstrates that digital teaching methods were assessed slightly more positively than traditional methods.

However, the qualitative essay analysis demonstrates that positive acceptance of digital education should not be interpreted as unconditional digital well-being. The semantic analysis of student essays revealed several recurring themes associated with the positive effects of digitalization, including extensive learning opportunities, easier access to educational materials, more structured learning resources, flexibility in time management, and reduced anxiety in a familiar environment. At the same time, students also emphasized negative consequences, such as decreased physical and social activity, fear of direct personal interaction, and deterioration of physical well-being due to screen-related fatigue and overwork. These findings show that digital educational environments can simultaneously support learning efficiency and generate psychosocial risks. Table 5 summarizes the main semantic units identified in students' essays and groups them into positive and negative effects of the digitalization of education.

Table 4: Satisfaction with digital teaching methods.

| Answer options | Number of responses in % |
|---|---|
| Everything is fine, no changes needed | 15.75 |
| Overall good but could be improved | 58.9 |
| Improvements needed | 25.35 |
| Everything needs to change | 0.00 |

The qualitative findings demonstrate that students associate digitalization not only with flexibility and accessibility, but also with reduced physical activity, communication-related anxiety, and digital fatigue. These psychosocial reactions may also be interpreted in line with broader studies addressing anxiety-related maladaptive responses in young people [12].

From the standpoint of the proposed framework, these results justify the inclusion of a dedicated risk-awareness component in the analytical model. If the assessment relied only on satisfaction scores, the interpretation would remain overly optimistic and would fail to capture the negative behavioral and well-being-related effects reported by students. By contrast, combining quantitative satisfaction data with qualitative risk-related evidence makes the assessment more balanced, interpretable, and suitable for decision support. Therefore, digital readiness in higher education should be understood not only as acceptance of digital learning technologies, but also as the ability to participate in such environments safely and sustainably [7], [9], [10].

Table 5: Summary data of the analysis of the essays of the respondents.

| Condensed meaning | Themes | Generalized Topics |
|---|---|---|
| Extensive learning opportunities (from home, from work, during illness, etc.) | Extensive opportunities for digitalization | Positive effects of digitalization of education |
| More structured material | Easily accessible material for study | Positive effects of digitalization of education |
| Easier to search for information (links to articles, videos are given, texts are added) | Easily accessible material for study | Positive effects of digitalization of education |
| The ability to distribute time (longer or faster to study a particular course or topic) | Independence in education and self-regulation of time | Positive effects of digitalization of education |
| Ability to learn more information in context (using other textbooks, etc.) | Extensive opportunities for digitalization | Positive effects of digitalization of education |
| Reduced anxiety in a familiar environment | Anxiety reduction | Positive effects of digitalization of education |
| Less physical and social activity (no need to leave the house, communicate directly) | Decreased activity and productivity | Negative effects of digitalization of education |
| Fear of personal contact outside the digital environment (fear of embarrassment in person, fear of the need for a quick response in a conversation) | Fear of being wrong | Negative effects of digitalization of education |
| Deterioration of physical well-being (great load on vision, decreased vision, pain in the back and shoulders, fatigue, overwork) | Ailments | Negative effects of digitalization of education |

Overall, the empirical results support the feasibility of converting survey-based and qualitative educational evidence into a rule-based digital assessment structure. The proposed model does not merely describe student attitudes but organizes them into a formalized logic for classification and recommendation generation. In this sense, the study contributes an applied framework that can be further extended into a prototype university monitoring tool for evaluating digital literacy and safe cybersocialization. This transformation from descriptive evidence to structured digital assessment constitutes the main practical contribution of the study.

# 5 DISCUSSION

The findings indicate that students generally demonstrate positive acceptance of digitalized education in terms of content, learning conditions, and digital teaching methods. However, the qualitative evidence shows that such acceptance does not automatically guarantee safe and sustainable participation in digital educational environments. The coexistence of positive learning opportunities and psychosocial risks supports the need for a balanced analytical model combining satisfaction-related and risk-related dimensions.

Within this pilot framework, digital literacy is interpreted not as technical proficiency alone, but as a composite of engagement in digitally mediated learning, acceptance of digital educational practices, and awareness of risks associated with online participation.

The main advantage of the proposed framework lies in its interpretability. The proposed framework complements data-driven approaches by providing interpretable rule-based decision logic. Unlike purely descriptive educational studies, the present approach converts heterogeneous evidence into a formalized rule-based structure that can support classification and recommendation generation. At the same time, the study has several limitations. First, the core framework was developed on a focused university sample of 146 students, which limits the generalizability of the results. In addition, the present revision does not include an independent validation sample or real institutional pilot deployment; therefore, the current results should be interpreted as a prototype-oriented methodological demonstration rather than as a fully validated operational system. Further validation on independent datasets is required to confirm the stability and generalizability of the proposed framework. Second, the weighting coefficients and decision thresholds were defined in a pilot heuristic manner and should be further validated on larger and more diverse samples. Third, the qualitative scoring procedure, although structured, still depends on interpretive coding and would benefit from further expert-based validation and inter-rater consistency testing. Future research may therefore focus on broader empirical validation, automated

coding support, and integration of the framework into real university digital platforms. Several additional methodological limitations should also be acknowledged. First, the weighting coefficients were assigned through the authors' own expert-informed heuristic judgment rather than a formal, documented expert-elicitation procedure (e.g., Delphi method or pairwise comparison), and the full item-level questionnaire was not included as an appendix; both aspects reduce the transparency and external reproducibility of the scoring logic and should be addressed in future work. Second, the percentages reported in Tables 1–4 are based on a single-item, ordinal response scale for each dimension; standard deviations and confidence intervals are not reported, and, in particular, the 0.00% response rate for the most critical option ("Everything needs to change") regarding digital teaching methods should be interpreted with caution given the limited sample size and self-selection effects rather than as evidence of the complete absence of strongly negative attitudes. Third, the thematic frequencies underlying Table 5 were not tabulated numerically, and the essay coding was not independently cross-checked by a second coder; inter-rater reliability testing is therefore identified as a priority for subsequent validation. Finally, social desirability bias may have influenced students' self-reported satisfaction levels and was not explicitly assessed in the present design.

# 6 CONCLUSIONS

This study developed a rule-based digital assessment framework for evaluating students' digital literacy and safe cybersocialization in higher education. The proposed approach transforms questionnaire-based and qualitative evidence into a structured analytical model that supports scoring, classification, and recommendation generation. Its main contribution lies in moving beyond descriptive interpretation toward an applied and interpretable decision-support framework suitable for prototype implementation in university digital environments.

The empirical results indicate that students generally accept digitalized education positively, especially in relation to educational content and digital teaching methods, while qualitative analysis reveals important psychosocial risks such as reduced physical activity, communication-related anxiety, and digital fatigue. These findings confirm that digital readiness should be evaluated not only through acceptance of digital tools but also through awareness of safe and sustainable online participation.

The proposed framework can serve as a basis for future implementation in LMS platforms, university dashboards, and internal monitoring systems. Further work should focus on validating the model on larger samples, refining the weighting and threshold logic, and improving the formalization of qualitative assessment.

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