MANAGING EDUCATIONAL INSTITUTIONS IN THE CONTEXT OF DIGITAL TRANSFORMATION: INFORMATION AND ANALYTICAL MECHANISMS FOR INCREASING THE EFFECTIVENESS OF INNOVATIVE MANAGEMENT

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Abstract. The article distinguishes digitisation from digital transformation in educational institutions and proposes an information and analytical mechanism for increasing the effectiveness of innovative management. Based on a theoretical analysis of digital maturity approaches, pedagogical-technological competencies and technology acceptance models, the study develops a digital maturity matrix for educational institutions, a five-component information and analytical mechanism, and a six-step decision-making cycle. Risks related to data privacy, algorithmic bias and the digital divide, as well as mitigation measures, are also systematised.

Keywords: digital transformation, educational management, innovative management, data governance, digital maturity, decision-making, monitoring.

INTRODUCTION

Digital technologies are fundamentally changing the way educational institutions work: from electronic registers and learning management systems to distance-learning platforms and analytical dashboards that support managerial decisions. In Uzbekistan this process is regarded as a part of state policy: the Development Strategy of New Uzbekistan [1], the concept for developing the higher education system [2] and the Law "On Education" [3] define the use of modern information technologies as a priority for improving the quality of education. OECD research also emphasises that digital technologies are becoming an important

condition for innovative education, but that their impact depends on organisational and pedagogical conditions [4, p. 12].

At the same time, in practice digitisation (transferring paper-based processes into electronic form) is often confused with digital transformation (a change in the management model and in the way value is created). As a result, educational institutions accumulate information systems that are not connected to one another, data are duplicated in different places, and managerial decisions rely, as before, on experience and guesswork. G. Westerman and colleagues single out two factors of success in digital transformation – the intensity of technology use and the intensity of managing it [5, p. 18]; if the managerial side is underdeveloped, technology does not provide an advantage.

Several aspects of this problem have been covered in the scholarly literature. E. Rogers explains the diffusion of innovations through the innovation-decision process and categories of adopters [6, p. 169]; F. Davis demonstrates the decisive influence of perceived usefulness and perceived ease of use on technology acceptance [7, p. 320]; P. Mishra and M. Koehler substantiate the interrelation of pedagogical, technological and content knowledge (TPACK) [8, p. 1025]; a working group led by C. Redecker systematised teachers' digital competencies in six areas [9, p. 15]. B. Williamson, in turn, takes a critical approach to the political and ethical aspects of data-driven governance, alongside the opportunities offered by big data in education [10, p. 12].

Most existing works focus on the level of the teacher or the learning process, while institution-level management, that is, the path by which data obtained through digital tools turn into managerial decisions, is covered less. The aim of the study is to develop an information and analytical mechanism that contributes to increasing the effectiveness of innovative management in an educational institution in the context of digital transformation. To achieve it, the following objectives were addressed: (1) to distinguish the levels of digitisation and digital transformation; (2) to substantiate a digital maturity matrix for an educational institution; (3) to design the components of

the information and analytical mechanism and the decision-making cycle; (4) to identify the risks of applying the mechanism.

Working hypothesis: if data sources are integrated into a single architecture, data governance, analysis and the decision-making cycle are regulated, and the digital competencies of leaders and teachers are developed, digital tools become a factor that increases the effectiveness of innovative management.

METHODS

The study is theoretical and analytical in nature. Its stages were: (1) a systematic analysis of international sources on digital transformation, digital maturity, technology acceptance and teachers' digital competencies; (2) a comparison of these approaches from the standpoint of managing an educational institution; (3) a content analysis of regulatory documents for requirements related to digital development; (4) process modelling (data flow and decision-making cycle); (5) identifying risks and systematising measures to mitigate them.

In substantiating the digital maturity matrix, the two-dimensional approach of Westerman and colleagues [5, p. 18] was adapted to the conditions of an educational institution. The decision-making cycle relies on the plan–do–study–act (PDCA) cycle described by W.E. Deming [11, p. 88]. The components of the information and analytical mechanism were selected on three criteria: data quality, direct influence on the decision-making process, and dependence on staff readiness. There are no primary empirical data among the sources used; this is a limitation of the study, and the conclusions are theoretical and design-based.

RESULTS

1. Levels of digitisation and digital transformation

The analysis showed that it is appropriate to distinguish three levels of digital development (Table 1). At the first level, existing processes remain unchanged and are merely transferred to electronic form; at the second, processes and systems are linked in a single data environment; at the third, digital capabilities change the institution's operating model and the way it creates value. Many institutions stay at the first level and describe it as "transformation"; this halts further development.

Table 1. Three levels of digital development (in an educational institution)

Level	Essence	Example in an educational institution	Managerial result
1. Digitisation	Transferring existing processes into electronic form	Electronic register; scanned copies of documents	Time is saved, but decisions do not change
2. Integration	Linking processes and systems in a single data environment	Learning management system; combining HR and finance data	A single source of truth appears, analytical capacity expands
3. Digital transformation	Change in the operating model and in the way value is created	Personalised learning pathways; a data-based early warning system	Decisions rely on evidence, organisational culture changes

Source: adapted by the author from the approach of Westerman et al. [5, p. 18].

2. A digital maturity matrix for an educational institution

Westerman and colleagues divided companies into four categories according to the intensity of digital capabilities and of managing them [5, p. 18]. For an educational institution this approach was adapted as follows: the first dimension is technological capability (infrastructure, platforms, digital resources); the second is managerial capability (data policy, leadership, staff competencies, culture of decision-making). As a result, four categories were formed (Table 2). The practical value of the matrix is that it answers the leader's question "which side should we invest in?": an institution with high technological capability but weak management needs not new software but data governance and staff training.

Table 2. Digital maturity categories of an educational institution

Category	Technological capability	Managerial capability	Characteristic feature	Priority task
Beginner	Low	Low	Isolated initiatives, no systemic approach	Digital strategy and infrastructure basics
Technology-oriented	High	Low	Many applications, but they are not connected and results are not measured	Data governance, single architecture

Category	Technological capability	Managerial capability	Characteristic feature	Priority task
Traditional-cautious	Low	High	Management is orderly, but technology is little used	Gradual increase of capabilities
Digitally mature	High	High	Technology and management are aligned, decisions rely on data	Continuous improvement, spreading experience

Source: adapted by the author for an educational institution on the basis of the model of Westerman et al. [5, p. 18].

3. Components of the information and analytical mechanism

The information and analytical mechanism is substantiated as consisting of five interrelated components (Table 3). The first component is a single data architecture: it determines which information is taken from which source in the learning management system, the education data base, and the HR, finance, library and communication systems. The second component is data governance: data owners, quality criteria, access rights and personal data protection rules are defined. The third component is the analytical layer: a dashboard of indicators, early-warning signs and trend monitoring. The fourth component is the decision-making cycle, which turns analytical results into specific managerial decisions. The fifth component is culture and competencies: developing digital competencies and an environment that supports the use of data.

In designing the fifth component, the DigCompEdu framework was taken as a basis: it describes teachers' digital competencies in six areas – professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learners' digital competence [9, p. 15]. The TPACK model, in turn, warns against the risk of separating technology from pedagogical goals and turning it into an end in itself [8, p. 1025].

Table 3. Components of the information and analytical mechanism

Component	Content	Responsible	Output
1. Single data architecture	Mapping sources; bringing data to a single format; eliminating duplication	IT officer; deputy director	Single source of truth

Component	Content	Responsible	Output
2. Data governance	Data owners, quality criteria, privacy and access rules	Leader; data officer	Reliable and protected data
3. Analytical layer	Dashboard of indicators; early-warning signs; trend analysis	Analytical team; methodological service	Analytical information ready for decisions
4. Decision-making cycle	Signal – diagnosis – options – decision – implementation – review	Leader; pedagogical council	Evidence-based managerial decisions
5. Culture and competencies	Developing digital competencies; encouraging the use of data	Leader; HR service	Technology acceptance and use

Source: compiled by the author.

4. A six-step decision-making cycle

Relying on the Deming cycle [11, p. 88], the decision-making cycle was designed in six steps. Signal: an indicator on the dashboard deviates from the norm (for example, a decline in attainment in certain classes or an increase in teachers' workload). Diagnosis: comparing with additional data (observation, interviews, surveys) to identify causes. Options: assessing several solutions and their resources and risks. Decision: clearly defining the person responsible, the deadline and the expected result. Implementation: executing the decision with interim monitoring. Review: comparing the result with the planned indicators and drawing conclusions for the next cycle. This cycle regularly answers the question "what is working and what is not" in implementing innovations.

The acceptance of the mechanism depends not only on technical but also on psychological factors. According to Davis's model, a user is more likely to accept a technology if they perceive it as useful and easy to use [7, p. 320]; Rogers distinguishes such attributes as relative advantage, compatibility, complexity, trialability and observability [6, p. 15]. Therefore, when introducing the dashboard, it should be presented to teachers as something that brings real benefit, is simple and can be tried out: for example, first testing it in one or two classes and showing the results openly.

5. Risks and measures to reduce them

Data-driven management also brings its own risks. Williamson notes that as data collection in education expands, management may come to rely excessively on surveillance and control [10, p. 12]. Table 4 systematises the main risks and the measures against them.

Table 4. Risks of the information and analytical mechanism and measures to reduce them

Risk	Essence	Mitigation measures
Data privacy	Personal data of learners and staff are used without permission or disclosed	Access rights matrix; data minimisation; rules for staff
Algorithmic bias	Analytical models produce biased conclusions about certain groups	Human review of results; using early warning as a means of support, not punishment
Digital divide	Teachers' and learners' access to and use of technology are unequal	Equalising infrastructure; additional skills support
Technostress and workload	The growing number of reports and platforms increases teachers' workload	Eliminating double entry; the principle of entering data once
Technological dependence	Being tied to one supplier and being unable to move data to another system	Open formats; including data export terms in contracts

Source: compiled by the author.

DISCUSSION

The results confirm the need to treat digital transformation as a managerial rather than technological process. This conclusion is consistent with the view of Westerman and colleagues about the decisive importance of management intensity in digital maturity [5, p. 18]. At the same time, the specific feature of the education sector is that "value" is measured not only financially but through learning outcomes and the learner's development; therefore, the analytical layer of the information and analytical mechanism should rely on indicators of learning outcomes. In J. Hattie's research, the value of 0.40 in effect size is used as a practically meaningful "hinge point" [12, p. 16]; this approach can serve as a criterion in assessing the impact of an innovation.

A strength of the mechanism is that it does not reject existing information systems but integrates them from the standpoint of managerial decisions. Its

weakness is that its success depends on the readiness of leaders and teachers to use data. Fullan draws attention to the decisive role of people and the relationships among them in educational change [13, p. 70]. Therefore, the fifth component (culture and competencies) should be developed simultaneously with the other four.

Limitations of the study: the mechanism is theoretical and design-based and has not been tested in a specific institution; the digital maturity categories and the risk table should be confirmed through expert assessment. In future research, it is planned to pilot the mechanism in several types of institutions (general secondary schools, vocational education, higher education) and to study the relationship between maturity level and management results.

CONCLUSION

The results of the study made it possible to draw the following conclusions:

digitisation, its integration and digital transformation are different levels of digital development, and the effectiveness of innovative management appears at the third level, that is, when the management model changes;

the digital maturity of an educational institution is determined by the alignment of technological and managerial capabilities; the two-dimensional matrix helps the leader to determine the direction of investment;

the information and analytical mechanism consists of five components (data architecture, data governance, analytical layer, decision-making cycle, culture and competencies) and is linked to management practice through a six-step decision-making cycle;

in introducing the mechanism, the risks of data privacy, algorithmic bias, digital divide, technostress and technological dependence should be taken into account in advance.

Practical recommendations: to conduct digital maturity diagnostics in every educational institution and draw up a development roadmap; to adopt internal rules on data governance; to define the position or function of a data officer; to introduce the analytical dashboard initially as a pilot with a limited set of indicators; and to

align digital competence development programmes for leaders and teachers with management goals.

REFERENCES

1. Decree of the President of the Republic of Uzbekistan No. PF-60 of 28 January 2022 "On the Development Strategy of New Uzbekistan for 2022–2026" // National Database of Legislation of the Republic of Uzbekistan. – URL: https://lex.uz (In Uzbek)

2. Decree of the President of the Republic of Uzbekistan No. PF-5847 of 8 October 2019 "On approval of the Concept for the development of the higher education system of the Republic of Uzbekistan until 2030" // National Database of Legislation of the Republic of Uzbekistan. – URL: https://lex.uz (In Uzbek)

3. Law of the Republic of Uzbekistan "On Education" No. ZRU-637 of 23 September 2020 // National Database of Legislation of the Republic of Uzbekistan. – URL: https://lex.uz (In Uzbek)

4. OECD. Innovating Education and Educating for Innovation: The Power of Digital Technologies and Skills. – Paris: OECD Publishing, 2016. – 152 p.

5. Westerman G., Bonnet D., McAfee A. Leading Digital: Turning Technology into Business Transformation. – Boston: Harvard Business Review Press, 2014. – 304 p.

6. Rogers E.M. Diffusion of Innovations. 5th ed. – New York: Free Press, 2003. – 576 p.

7. Davis F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology // MIS Quarterly. – 1989. – Vol. 13, No. 3. – P. 319–340.

8. Mishra P., Koehler M.J. Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge // Teachers College Record. – 2006. – Vol. 108, No. 6. – P. 1017–1054.

9. Redecker C. European Framework for the Digital Competence of Educators: DigCompEdu. – Luxembourg: Publications Office of the European Union, 2017. – 95 p.

10. Williamson B. Big Data in Education: The Digital Future of Learning, Policy and Practice. – London: SAGE, 2017. – 256 p.

11. Deming W.E. Out of the Crisis. – Cambridge, MA: MIT Center for Advanced Engineering Study, 1986. – 507 p.

12. Hattie J. Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement. – London: Routledge, 2009. – 378 p.

13. Fullan M. The New Meaning of Educational Change. 5th ed. – New York: Teachers College Press, 2016. – 328 p.