DIDACTIC FOUNDATIONS FOR USING MOBILE APPLICATIONS TO DEVELOP THE PROFESSIONAL COMPETENCIES OF TECHNOLOGICAL EDUCATION STUDENTS

Saidova Muhayyo Farhod qizi

Doctoral Researcher (PhD), Bukhara State Pedagogical Institute, Bukhara, Uzbekistan

Abstract. Digital technologies are reshaping higher education, yet the mere availability of mobile applications does not improve learning; their value depends on how they are designed and integrated pedagogically. This article analyses, at a theoretical and methodological level, the didactic foundations for using mobile applications to develop the professional competencies of students in Technological Education, a teacher-training programme with a strong practical component. Drawing on international meta-analyses and systematic reviews and on established theories of multimedia learning, cognitive load, feedback and technology integration, the study (1) proposes six didactic principles for mobile-supported learning, (2) systematises six didactic functions of mobile applications and links them to the competencies they are expected to support, and (3) outlines a five-stage methodological mechanism for integrating mobile applications into instruction, illustrated with two textile-related courses. The article is conceptual: it reports no experimental results, and the proposed links between functions and competencies are hypotheses that require testing in a pedagogical experiment. The framework may help instructors and course designers in practice-oriented programmes to use mobile applications as a structured didactic tool rather than merely as a channel for delivering content.

Keywords: mobile learning; mobile applications; professional competence; technological education; didactic principles; digital learning environment; interactive learning; microlearning; independent learning; vocational teacher education.

1. Introduction.

The rapid development of digital technologies in higher education makes it necessary to improve the content of education, teaching methods and the forms in which learning activity is organised. In the preparation of future teachers, the purposeful use of digital learning resources, the greater interactivity of instruction and support for students' independent learning are among the most pressing pedagogical tasks. In Uzbekistan, the digitalisation of education is part of state policy: the "Digital Uzbekistan – 2030" Strategy was approved by Presidential Decree No. UP-6079 of 5 October 2020 [1], and the development of the higher education system is guided by the Concept approved by Presidential Decree No. UP-5847 of 8 October 2019, which runs to 2030 [2].

Among digital learning tools, mobile applications stand out for their convenience, rapid access to information and the possibility of continuing learning outside the classroom. Learning organised through mobile devices creates additional opportunities to take into account students' individual needs, prior knowledge and pace of learning. However, the presence of mobile technology does not in itself guarantee better educational quality. Its pedagogical effectiveness depends on alignment with learning goals, didactic grounding and methodologically sound integration into the learning process. The UNESCO 2023 Global Education Monitoring Report makes a similar point: it recommends that technology be introduced into education on the basis of evidence that it is appropriate, equitable, scalable and sustainable, and it notes that robust evidence on the added value of digital technology in education is limited [3].

The issue is particularly important in Technological Education. Students in this programme (here, with a textile and garment specialisation) must not only acquire theoretical knowledge but also understand technological processes, perform practical operations, analyse the properties of materials, plan technological sequences and make

independent decisions in professional situations. Some complex technological processes are hard to convey fully through verbal explanation or static images alone. Animations, video lessons, interactive tasks and visual models integrated into mobile applications can extend the possibilities for studying such processes step by step. At the same time, they do not replace practical sessions; they serve to prepare students for practical activity and to consolidate what has been learned.

To the author's knowledge, existing syntheses of mobile-learning research (reviewed in Section 2) mainly address whether mobile learning improves learning performance and how the field is developing. The specific didactic conditions under which mobile applications support competence development in practice-oriented teacher-training programmes appear to be less systematically described. The **aim** of this study is therefore to identify the didactic foundations for using mobile applications to develop the professional competencies of Technological Education students, to systematise their pedagogical functions, and to substantiate the methodological conditions for integrating them into the learning process. Three research questions guide the analysis:

RQ1. Which didactic principles should govern the use of mobile applications in practice-oriented technological education?

RQ2. Which didactic functions of mobile applications can be linked to which components of professional competence?

RQ3. What staged methodological mechanism can connect mobile-supported preparation with real practical activity?

2. Literature review and methodology

2.1 Methodology

The study is theoretical and methodological in nature. It uses the analysis of scholarly literature, comparison of pedagogical approaches, classification of didactic affordances, generalisation and methodological modelling. The literature base consists

mainly of meta-analyses and systematic reviews of mobile learning, supplemented by theoretical frameworks on technology integration, multimedia learning, cognitive load and feedback. Within this base, mobile applications are examined as didactic tools within a competence-based, activity-oriented, systemic and learner-centred approach.

2.2 Mobile learning research: what the reviews show

Mobile learning has been conceptualised as the processes of coming to know through conversations across multiple contexts among people and personal interactive technologies [4]. Its effectiveness and research trends have been examined from several angles. In a meta-analysis of 110 experimental and quasi-experimental journal articles published between 1993 and 2013, Sung, Chang and Liu found a moderate mean effect size of 0.523 for integrating mobile devices (laptops, personal digital assistants and mobile phones) into teaching and learning [5]. This result shows the educational potential of mobile technology. It does not, however, mean that mobile tools give the same results in every discipline and pedagogical setting, and it concerns mobile devices in general rather than specific applications.

Other syntheses describe how the field has developed. Wu et al. analysed 164 studies from 2003 to 2010 and found that most focused on effectiveness, followed by system design [6]. Hwang and Tsai reviewed 154 articles from six technology-enhanced learning journals published in 2001–2010 [7]. Crompton and Burke analysed 72 studies of mobile learning in higher education from 2010 to 2016 and reported that the majority examined the impact of mobile learning on student achievement [8]. Krull and Duart, reviewing higher-education articles from 2011 to 2015, found that the most common research topic was enabling m-learning applications and systems, and that mobile phones were the most widely used devices [9].

Taken together, these reviews show a research emphasis on whether mobile learning works and on how systems are built. It follows that the didactic significance of mobile applications should not be limited to their capacity to deliver electronic

materials. They should be viewed as pedagogical tools that support the planning, management and monitoring of learning, reflection and independent mastery of content. From the standpoint of professional competence, the main feature of mobile learning is its capacity to link theoretical knowledge with practical tasks, to make learning continuous and to create an environment suited to each student's developmental needs.

2.3 Evidence from practice-oriented and vocational education

Two studies are close to the context of this article. A systematic review and meta-analysis of mobile digital education for health professions found that, for skills outcomes, the pooled estimate favoured mobile learning over traditional learning (SMD = 1.12, 95% CI 0.56–1.69, five studies, moderate-quality evidence), and the authors concluded that mobile learning is as effective as traditional learning or possibly more so [10]. In vocational education, a quasi-experimental study with 80 undergraduate students in a practice-based course compared conventional instruction with mobile microlearning based on short (2–6 minute) videos aligned with procedural steps, safety checkpoints and quality criteria, which students could rewatch before and after workshop practice. The experimental group achieved significantly higher delayed practical performance and procedural knowledge, with fewer procedural errors and faster task completion [11]. Both studies come from other fields and contexts, so they are indirect support rather than proof for Technological Education.

3. Results

3.1 Core didactic principles for using mobile applications

Effective integration of mobile applications into technological education requires reliance on specific didactic principles. Six are proposed.

First, the principle of scientific rigour and content coherence ensures that the materials presented in the application conform to the content of the discipline, to scientific concepts and to the logical sequence of technological processes. Lectures,

practical tasks and assessment instruments should serve a single learning goal. This is consistent with the view that effective teaching with technology depends on the interplay of content, pedagogy and technology [12].

Second, the principle of visualisation and multimodality provides for presenting complex technological processes through text, images, animation, video and interactive models, which helps students link abstract concepts with concrete processes. The cognitive theory of multimedia learning assumes separate visual and verbal channels, limited processing capacity and active processing by the learner [13]. Because cognitive load can exceed learners' capacity [14, 15], excessive use of multimedia may be counterproductive, and visual materials should be selected to match the learning task; the design of instructional video is discussed in [16].

Third, the principle of individualisation and adaptability gives students the opportunity to control the pace at which they master material, to return to difficult topics and to consolidate knowledge through additional exercises.

Fourth, the principle of interactivity and active participation aims to turn the student from a passive recipient of information into an active participant in learning. Situational tasks, exercises on identifying the technological sequence, interactive tests and problem questions in the application are its practical expression.

Fifth, the principle of feedback and reflective assessment aims to ensure that students receive prompt information about their results, analyse their errors and plan further learning consciously. The effect of feedback depends on its type and on how it is given [17], so feedback should do more than mark an answer as right or wrong: it should help students understand the goal, their current position and the next step.

Sixth, the principle of integrating theory and practice provides that knowledge acquired through mobile learning is applied in laboratory and practical sessions. This principle is essential given the professional and practical character of technological education.

3.2 Functional possibilities of mobile applications for developing professional competencies

Considering the didactic functions of mobile applications in relation to the structure of professional competence helps to define their pedagogical possibilities more precisely (Table 1).

Table 1. Relationship between the didactic functions of mobile applications and professional competencies

Didactic function	Educational tools	Competence developed
Informational–educational	Electronic lecture, glossary	Professional knowledge and concepts
Visualising	Video, animation, diagram	Understanding of technological processes
Practice-oriented	Interactive task, algorithm	Technological and practical competence
Control–analytical	Test, analysis of results	Self-assessment and reflection
Motivational	Staged tasks	Learning motivation and engagement
Organisational–managerial	Learning modules, individual progress tracking	Independent learning competence

Source: developed by the author on the basis of theoretical and methodological generalisation.

The relationships in Table 1 express the expected pedagogical link between individual tools of a mobile application and particular professional competencies. Their practical effectiveness can be established only through a dedicated pedagogical experiment and diagnostic assessment.

In a learning process organised through mobile applications, it is important that theoretical materials, practical exercises and assessment tools complement one another. For example, a student first studies the theoretical basis of a technological process,

then observes its visual demonstration, completes an interactive task and finally checks their knowledge with control questions. This sequence provides a methodological basis for moving from acquiring knowledge to applying it.

3.3 Methodological features of teaching technological subjects with mobile applications

The possibilities of mobile applications in Technological Education can be examined using two courses as examples: Fabric Materials Science (*Gazlamalar materialshunosligi*) and the Fabric Processing Practicum (*Gazlamalarga ishlov berish praktikumi*).

In Fabric Materials Science, forming knowledge about the structure and properties of natural and chemical fibres, fabric weaves and the physical and mechanical properties of materials is central. When studying these topics, microscopic images, comparative tables, technological animations and interactive tasks increase the visual clarity of the material. For example, in a mobile task on distinguishing natural from chemical fibres, students can be shown microscopic images of different fibres and asked to identify their external structure and characteristic features. This approach links theoretical knowledge with visual analysis. In the laboratory, the knowledge gained is then consolidated by observing real samples under a microscope.

In the Fabric Processing Practicum, practical skills have priority: making garments, determining the sequence of technological operations, performing hand and machine seams, taking measurements and working with patterns. Within this course, mobile applications can provide video materials that show technological operations step by step, graphic algorithms and situational tasks. For example, when processing individual parts of a garment, the student first studies the visual algorithm of the operation, then performs it in a practical session, and finally evaluates the quality of the work against defined criteria.

Thus, in technological education mobile applications can serve as a didactic tool that prepares students' theoretical knowledge for practical activity and supports independent study.

3.4 A methodological mechanism for integrating mobile applications into the learning process

The study proposes a methodological mechanism consisting of five interrelated stages (Table 2).

Table 2. Five-stage methodological mechanism for using mobile applications

Stage	Content of the stage	Illustration (Fabric Processing Practicum)
1. Goal-oriented and content preparation	Learning goals, target competencies, key concepts and expected outcomes are defined; the application's resources are aligned with the syllabus.	The garment-component operation to be mastered and the criteria for its quality are defined.
2. Visual-informational learning	Students study lecture materials, video lessons, animations, diagrams and other visual resources; priority is understanding the content and the sequence of the process.	Step-by-step video and a graphic algorithm of the operation.
3. Interactive-practical activity	Students complete interactive exercises, problem tasks and tasks that analyse practical situations, applying knowledge in new learning situations.	Ordering the technological steps; situational tasks.
4. Control and reflection	Embedded tests, diagnostic tasks and analysis of results establish mastery; students receive feedback on errors and can revisit topics.	Short test on the operation sequence with feedback on errors.
5. Practical transfer	Knowledge and skills are applied in laboratory work, practical sessions and professional situations; students perform operations independently and evaluate the result.	The operation is performed in the workshop and the product is assessed against the criteria.

Source: developed by the author.

Stage 1 – goal-oriented and content preparation. At this stage the learning goals, the competencies to be formed, the key concepts of the topic and the expected learning outcomes are determined. The educational resources in the mobile application are developed in line with the course syllabus and learning goals.

Stage 2 – visual-informational learning. Students become acquainted, through the mobile application, with lecture materials, video lessons, animations, diagrams and other visual resources. Priority is given to understanding the content of technological processes and the sequence in which they are performed.

Stage 3 – interactive-practical activity. Students carry out interactive exercises, problem tasks and tasks aimed at analysing practical situations. Besides repeating knowledge, attention is paid to applying it in new learning situations.

Stage 4 – control and reflection. Students' mastery is established through tests, diagnostic tasks and analysis of results integrated into the application. Students receive feedback on their errors and can study the necessary topics again.

Stage 5 – practical transfer. Knowledge and skills acquired in mobile learning are applied in laboratory work, practical sessions and professional situations. At this stage particular attention is paid to the student's ability to perform technological operations independently and to evaluate the result.

The distinctive feature of the proposed mechanism is that mobile learning is interpreted not merely as the electronic delivery of learning materials but as staged didactic activity directed at developing professional competencies. In this approach the logical sequence of learning modules, small content units, interactive tasks and regular feedback are combined, which creates a methodological opportunity to unite elements of mobile microlearning (see the review in [18]) with the practical character of technological education.

4. Discussion

The pooled effect of 0.523 reported in the meta-analysis [5] and the focus of later reviews on student achievement [8] indicate that mobile learning is promising, but they say little about the pedagogical mechanisms behind that promise. In line with the UNESCO call to ground technology use in evidence [3], the framework proposed here does not assume that mobile applications are effective; it specifies the conditions (principles, functions, stages) under which their effect can be designed for and then tested.

The five-stage mechanism is consistent with indirect evidence from practice-oriented education. The vocational study discussed in Section 2.3 [11] used short procedure-aligned videos that students could revisit (Stage 2) around real workshop practice (Stage 5) and found gains in delayed practical performance, and the health-professions review [10] reported favourable pooled estimates for skills. Because these studies concern other fields, the present framework should be viewed as a hypothesis for Technological Education, not as a confirmed result.

Several practical conditions must be considered when mobile applications are introduced: the technical capabilities of students' devices, the quality of internet access, the level of digital literacy, the ergonomic suitability of learning materials and the instructor's digital competence. This accords with UNESCO's identification of access to technology, governance and teacher preparation as system-wide conditions for technology to reach its potential in education [3]. In assessing learning outcomes, it is also advisable not to rely only on mobile test results, but to observe practical activity directly and to evaluate the quality of the product against criteria.

Limitations. The article is conceptual and reports no empirical data. The evidence it draws on is largely secondary and comes partly from other disciplines. The links in Table 1 are expected, not demonstrated, relationships, and the effects of particular application features (for example, video length or the type of feedback) were

not examined. The illustrations are drawn from two textile-related courses, and transfer to other technological specialisations remains to be established.

5. Conclusion

The analysis of the didactic foundations for using mobile applications in developing the professional competencies of Technological Education students allows the following scientific and methodological conclusions.

First, in technological education mobile applications can, besides presenting learning materials, support the organisation of students' independent learning, the visualisation of technological processes, the consolidation of knowledge and reflective assessment.

Second, realising the pedagogical potential of mobile applications requires methodological organisation based on the principles of scientific rigour, visualisation, individualisation, interactivity, feedback, and the integration of theory and practice.

Third, the professional and practical character of technological education requires the theoretical materials, visual resources, interactive tasks and assessment tools in mobile applications to be closely linked with real practical activity.

Fourth, the proposed five-stage methodological mechanism can be regarded as a theoretical and methodological basis for organising mobile learning resources in line with the aim of developing professional competencies.

Fifth, to establish the actual effectiveness of learning organised through mobile applications, diagnostic criteria covering students' theoretical knowledge, technological and practical skills, capacity for independent work and reflective competence should be developed and tested through a pedagogical experiment.

Overall, the didactically grounded use of mobile applications is a promising methodological direction for implementing the competence-based approach in technological education, strengthening the integration of theoretical and practical preparation and supporting students' individual learning activity.

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