Integrated Educational Media System for Mining Transport within Mining Engineering Degree Program

Sistema integrado de medios de enseñanza para la asignatura Transporte Minero de la carrera Ingeniería en Minas

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Abstract: This paper stablishes a strategy for the progressive development of an Integrated Educational Media System for Mining Transport, taught within the Mining Engineering Degree Program at the University of Moa, in order to improve students' self-learning and teachers' process handling under any pedagogical circumstances. To fulfill this purpose, the syllabus, the teacher's guide, the study guide, basic and complementary texts were consulted. A conceptual map of the subject is elaborated following the cognitive learning theory.

Key words: distance learning, blended learning, mining mechanization, educational resources

Resumen: Se estableció una estrategia para el desarrollo progresivo de un Sistema Integrado de Medios de Enseñanza y Aprendizaje para la asignatura Transporte Minero de la carrera Ingeniería en Minas de la Universidad de Moa para facilitar el autoaprendizaje de los estudiantes y la conducción del proceso a los profesores bajo cualquier circunstancia pedagógica. Para el desarrollo del sistema integrado de medios de enseñanza se consultó el programa de la asignatura, los textos básicos, la guía del profesor y de estudio y los textos complementarios. Se elabora un mapa conceptual de la asignatura siguiendo la teoría cognitiva de aprendizaje.

Palabras clave: educación a distancia, enseñanza semipresencial, mecanización minera, recursos educativos

Introduction

Distance education is considered a feasible alternative for professional improvement, which is why distance education proposals are rapidly advancing (García, 2017; Pichs & Ruiz, 2020; Hernández, Ruiz & Sepúlveda, 2022). According to Gil Mateos & García Martínez (2021), universities are undergoing changes in their adaptation to new conditions. Innovations have caused significant advances in communication ways, educational resources distribution, and learning communities' development.

In Cuban higher education, blended learning has become more relevant in the teaching-learning process starting from the "E" curriculum. Concepts such as study guide, meaningful learning, interactive learning, collaborative learning, and concept map, among others, were brought into pedagogical practice due to the pandemic situation the world went through (Alpízar & Velázquez, 2021; García *et al*., 2023; Estrada, Sam & de la Cruz, 2023). This situation proved that many degree programs, disciplines, and subjects were not prepared to face these pedagogical emergencies, thus highlighting the need to consciously apply these concepts.

The integration of mobile devices into education has revolutionized the way students access educational resources. With tablets and smartphones, students can access e-books, educational videos, interactive applications, and other resources at any time and place. This provides them with flexibility to study and learn at their own pace, which can improve their understanding and retention of information (Arjona Heredia & Gámiz Sánchez, 2015; Panchana *et al.,* 2017). Furthermore, access to educational resources on mobile devices allows students to explore topics of interest more deeply and broadly. They can search for information online, participate in academic discussion forums, and access virtual libraries to expand their knowledge beyond what is offered in the classroom (Jiménez-García & Martínez-Ortega, 2017; Delgado, 2019).

Integrated educational media systems are all the didactic, educational material means and technological resources that will be available to students and teachers to successfully carry out their teaching-learning process (Montero, 2010).

In this sense, Mining Transport, which is a subject within the discipline Mining Mechanization, lacks a strategy for the materialization of an Integrated Educational Media System (SIMEA, in its acronym in Spanish) that develops progressively, allowing

students and teachers to keep the subject updated and respond to the conceptual bases governing the "E" curriculum.

The subject lacks an integrated educational media system; therefore, by mastering its structure and content, it is possible to propose a strategy for the progressive development of a SIMEA that can be implemented at any pedagogical situation, in addition to the study modality and type of course: Full-time Learning Program (FT), Blended Learning Program (BL) and Distance Learning Program (DL).

This paper proposes to establish a strategy for the progressive development of an Integrated Educational Media System for Mining Transport, which facilitates students' self-learning and teachers´ process handling under any pedagogical circumstances.

Materials and Methods

The University of Moa´s Moodle platform was analyzed to know the platform´s progress status.

For the development of the integrated educational media system, the subject syllabus, teacher's guide, study guide, basic and complementary texts were consulted. Other materials for the development of the SIMEA, endorsed by Vidal Ledo *et al.*, (2007); Montero O'farrill, (2010), Moreira (2010); Pelegrín Rodríguez *et al*., (2013) Delgado, (2019); Ramos *et al*., (2022) are videos, multimedia, tutorials, simulators, and organizational charts.

SIMEAs must fulfill a set of general requirements, which are addressed in this paper (MES, 2007); however, some guideline elements must be updated due to ICTs development and the technological development, where the use of mobile devices in the teaching-learning process, access to e-learning platforms, among other current advantages related to technology, are alluded to.

The subject's concept map is elaborated following Ausubel's (1983) cognitive learning theory.

Characterization of Mining Transport

Mining Transport is taught in the FT and BL programs, and also has its own classroom at Minera del Caribe Mixed Company, in Pinar del Rio province, where it is taught through the BL program modality.

Mining Transport General Data

1- Subject´s general data and justification.

a) General data

Subject: Mining Transport

Specialty: Mining Engineering

Discipline: Mining Mechanization

Placement within the curriculum: third year, second semester for the regular full-time learning program (FT Program) and fourth year, first semester for the blended learning program (BL Program).

Total time allocation: 40 h (FT Course), 22 h (<).

Time allocation by organizational forms of teaching: Lessons: 40 h (CD), Blended Lesson: 22 h (BL Program). Research work, Consultation, and Student Self-Preparation. 60 h

Type of lessons: lectures (L), seminars (S), laboratories (T), and practical lessons (PL)

Subject Syllabus

Subject general objectives

1. To interpret the information provided by catalogs, apply materialist dialectical logical principles to rationally and safely choose and operate mining transport machines and installations; taking into consideration their interaction with the environment.

2. To contribute to understanding the world´s scientific conception by interpreting problems related to transport selection in mines.

3. To select the suitable types of transport for specific cases and calculate the basic parameters.

4. To organize and calculate transportation flows in mines and quarries, as well as the maintenance and equipment repair and transport routes in mining units.

Essential knowledge to be acquired:

General aspects of mining transport and the transportation process; historical development of transport facilities and means. Continuous transport facilities, their characteristics and calculation elements; automotive and railway transport, their characteristics and calculation elements; non-conventional transport: pneumatic, hydraulic, funiculars, cableways, and marine.

Main skills: Master the historical development of transport facilities and machinery; select transport based on its application scope. Determine the productive parameters of transport facilities and machinery. Know the interaction between these means with the environment, as well as their safe operation.

Subject's topics planning and organization

Table 1 presents the distribution in subject theoretical clusters and the class typologies according to the lesson plan.

Table 1. Class typology for Mining Transport

Themes/ Clusters	Denomination	Total Hours	L	PL	S	T
I	Transport general aspects. Theoretical foundations	10	4	4		2
II	Conveyors	10	4	4		2
III	Automotive transport	6	2	4		
IV	Railway transport	6	2	4		
V	Other types of transport	8	4		2	2
Totales		40	16	16	2	6

If the SIMEA addresses the theoretical clusters and didactic units, it will be more feasible to make changes in the way of teaching under any pedagogical situation; these aspects will be the changes that should be implemented in the subject according to the new study proposal.

Planning and organization by topics

Topic I. Transport general aspects. Theoretical foundations

Essential knowledge to be acquired:

Operating conditions and special requirements of transport means and facilities. Types and physical-mechanical properties of loads. Transport complexes. Machine's reliability and quality. Productivity of transport machinery. Load-bearing elements. Traction unit. Methods to transmit traction effort.

Main skills: Mastering mining transport basic concepts, the conditions of use for each type of transport. Calculating the basic and productive parameters of transport means or facilities.

Topic II. Conveyors

Essential knowledge to be acquired:

Significance of the use of conveyors in construction and mining. Application field, operating and construction principle; rake conveyors; slat conveyors; belt conveyors. Main elements for traction and operational calculation. Safety in conveyors operation; their interaction with the environment. Technical-economic indices. Loading and unloading points. Current trend in the use of conveyors.

Main skills: Mastering conveyor's purpose, application scope, operating principle and construction schemes. Calculating the basic operational and traction elements. Mastering the basic elements for the safe operation of conveyors and their interaction with the environment.

Topic III. Automotive transport

Essential knowledge to be acquired:

Automotive transport significance and role in cargo transportation at mining and mining construction scenarios. Automotive transport's application scope. Roadways for automotive transport. Layout and schemes. Generalities on dumpers construction. Basic parameters. Trailers. Operational calculation. Safe operation and interaction with the environment. Economic indices.

Main skills: To know the historical development of automotive transport. To master the purpose, application scope, operating principle and construction schemes of automotive transport (rigid, articulated, and trailers). To calculate the basic operational and traction elements. To master the basic elements of automotive transport safe operation and its interaction with the environment.

Topic IV. Railway transport

Essential knowledge to be acquired: To know the historical development of railway transport. Railway transport significance and role in cargo transportation at mining scenario. Application scope of railway transport. Railway tracks. Layout and schemes. Generalities on the construction of locomotives, traction aggregates, wagons and bogies; basic parameters. Operational calculation. Safe operation and interaction with the environment. Economic indices.

Main skills: To master railway transport's purpose, application scope, operating principle and construction schemes. To calculate the basic operational and traction elements. To master the basic elements of railway transport safe operation and its interaction with the environment.

Topic V. Other types of transport

Essential knowledge to be acquired:

Schemes and types of hydro-transport complexes. Pressure and gravity hydraulic transport facilities; general elements of hydraulic transport calculation.

Pneumatic transport, schemes used, funiculars, cableways. Application scope; construction characteristics and operating principle. Gravity transport. Generalities. Combined transport.

Main skills: To master the purpose and application scope of non-conventional transport and their combined use.

Methodological and organizational instructions

Mining Transport is taught in the second semester, during the 3rd year of Mining Engineering degree program. Due to the study of a wide variety of facilities and machines for transport, in which their construction characteristics, traction mechanisms, and transport ways are analyzed; it is necessary to use audiovisual media such as transparencies, diagrams, and the blackboard; the possibilities offered by the mineral processing laboratory can be used, which includes a belt conveyor facility as well as a wide set of auxiliary transport facilities.

Since most mining transport equipment and facilities manufacturers publish their materials in English, students must consult this bibliography and extract the necessary information to be able to select machines, create data sheets, and measure parameters to perform calculations.

The entire subject and assignments must be hosted within the interactive platform Moodle, which is why the results must be uploaded to this platform, as well as research work and research tasks.

Students must develop simple programs in Excel to calculate mining transport main technological parameters, they will also use Mathcad Software to determine Technical-Economic indices.

The content of this subject will be taught with the typologies and number of hours established for each study modality. In the case of the Blended Learning Program (BL), BL classes will use face-to-face activities to contribute to the development of students' cognitive independence and the opportunity to work student-teacher and student-student to consolidate skills requiring interaction.

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Basic text:

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Description of the integrated educational media system for Mining Transport

Figure 1 shows a conceptual map that includes the four stages, their contents, and each stage's time extent according to the timeline.

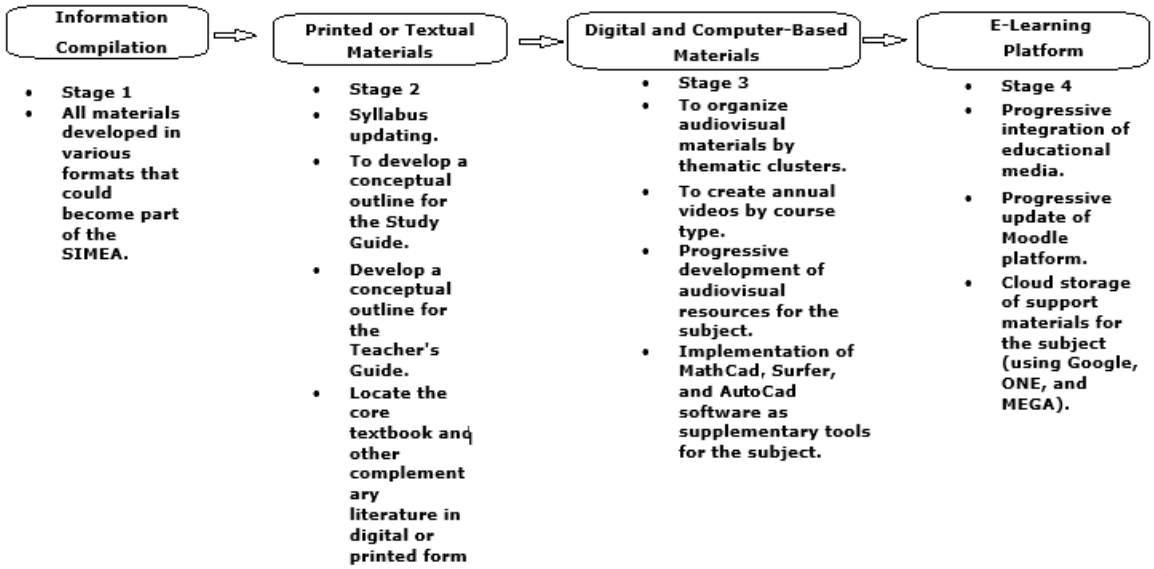

Figure 1. Concept map of contents to be developed in the strategy for SIMEA elaboration.

In Stage 1, all existing information and prepared materials in the University of Moa's information center are compiled, in various formats, predominating the digital format for both text and audiovisual multimedia.

Stage 2 is characterized by the annual updating of each type of course's subject analytical program and study guides for the teacher and for students.

In Stage 3, audiovisual materials must be developed with available means, and the recording of didactic videos with students resulting from internships and technical visits to mining companies must be achieved. Another aspect that should distinguish this stage is the development of exercises using softwares such as AutoCad or Surfer to identify and master terrain slopes, or MathCad to perform calculations to determine the technical-economic indicators of the different transport means. Lastly, AI elements (Chatbot) resulting from theses and research, recently developed by students of the program, that are aimed at didactic solutions for automotive transport selection, must be incorporated.

In Stage 4, the Moodle e-learning platform is updated. As the SIMEA's integrating tool, this platform is where higher-level actions must materialize, reaching down to an individual and collective assessment of the teaching-learning process, leveraging the institutional cloud. Other alternatives are also proposed, such as google drive, one drive, MEGA, Terabox, among others, as long as they allow hosting files in multiple formats and sharing them.

Another important aspect to achieve is the definition of the digital educational media that should or can be hosted on network cloud, prioritizing the institutional cloud. These actions promote exchange between students and collaborative learning based on the arising needs.

Outcomes of the Strategy to Progressively Develop the Integrated Educational Media System in Mining Transport

Base Material for Mining Transport

It is a material that presents the general structure of the subject, which was not divided into teaching activities by typology, but into Theoretical Clusters and Didactic Units.

Specialty: Mining Engineering

Curriculum Plan "E"

Mining Transport is taught face-to-face in the FT Program and in a blended manner in the BL Program; it is also possible for the subject to be taught at distance, due to a pandemic like COVID-19 or another unexpected pedagogical situation.

The subject contributes to values formation such as hard work, responsibility, teamwork, and leadership, among others. It equips future engineers with a comprehensive vision, they must be able to identify each transport means or facility used in mining, the specific conditions under which their implementation can be more efficient and effective. They will also master the characteristics of the roads for each type of transport, the requirements for transport facilities. Other aspects Mining Engineering students must know are:

- Basic parameters of the different transport means and facilities,

- How to determine the most important productive indicators such as productivity, required power for work, maintenance to ensure high availability, among other aspects,

- Organization of material flows based on the productive parameters of the equipment and the extraction order or productive characteristics of the mining company,

- Maintenance organization and planning for transport means and facilities.

Personalized space-time can be allocated to other topics, not initially considered, based on student interest

Figure 2 shows Mining Transport's theoretical conceptual map.

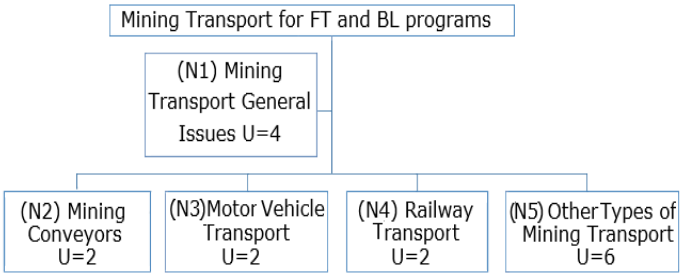

Figure 2. Theoretical conceptual map.

The subject comprises five theoretical clusters (N) and 16 didactic units (U) distributed into topics as shown in the conceptual map.

About the evaluation system

The subject may or may not have a final exam; according to the approved curriculum, a final exam is held for the BL Program and the FT program it is evaluated with a coursework, an aspect that can be changed according to circumstances.

Midterm exams, along with seminars and extra-class assignments, will be timely tasked using the Moodle platform; questions should be asked in the VLE where the subject is hosted and students are enrolled.

This knowledge is built in the student as the subject progresses in space and time. To achieve that and to facilitate the student's cognitive development, they must enroll in the subject, then watch the cluster-based videos and complete the unit-based tasks on the Moodle platform, through which students and teachers can keep a continuous exchange, upload and download tasks and other support materials for the subject, and take evaluations once the exercises and extra-class assignments are completed.

Conclusions

The strategy to progressively develop an Integrated Educational Media System for the Mining Transport within the Mining Engineering program at the University of Moa facilitates students self-learning and enables teachers to conduct the process across different study modalities.

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