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ORIGINAL

Analysis of the construction of knowledge in connection with industry

Análisis de la construcción del conocimiento en vinculación con la industria

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ABSTRACT

The term dual training is understood as a type of professional education, where the teaching-learning process takes place in two different places, the school and the industry. The knowledge management model is addressed through the conversion between tacit and explicit knowledge. The SECI model refers to a process of knowledge creation and transfer through four modes of knowledge conversion. When exploring current practices through a Likert-type scale that analyzed students' perception of knowledge management in a dual educational model, the results show significant differences in the perception of knowledge management between school-based and dual mode students, being more favorable for dual mode students in the factors of knowledge generation, application and tutoring. The factor analysis identified four key factors that explain 57,764 % of the total variance with four factors: knowledge generation and application, knowledge sharing, knowledge acquisition and application, and content tutoring. When performing Student's t-test for independent samples of the factors with modality, even more significant differences were found, with a p-value=-2,822, sig=0,005.

Keywords: SECI Model; Dual Training; Knowledge Management.

RESUMEN

El término de la formación dual se entiende un tipo de educación profesional, donde el proceso de enseñanza-aprendizaje se realiza en dos lugares distintos, la escuela y la industria. Se aborda el modelo de gestión de conocimiento a través de la conversión entre conocimiento tácito y explícito. El modelo SECI se refiere a un proceso de creación y transferencia de conocimiento a través de cuatro modos de conversión del conocimiento. Al explorar las prácticas actuales mediante una escala tipo Likert que analizó la percepción de los estudiantes sobre la gestión del conocimiento en un modelo educativo dual, los resultados muestran diferencias significativas en la percepción de la gestión del conocimiento entre los estudiantes de modalidad escolarizada y dual, siendo más favorable para los de modalidad dual en los factores de generación, aplicación y tutoría de conocimiento. El análisis factorial identificó cuatro factores clave que explican el 57,764 % de la varianza total con cuatro factores: generación y aplicación del conocimiento, compartir conocimiento, adquisición y aplicación del conocimiento, y tutoría de contenido. Al realizar la prueba t de Student para muestras independientes de los factores con la modalidad, se encontraron diferencias aún más significativas, con un valor p=-2,822, sig=0,005.

Palabras clave: Modelo SECI; Formación Dual; Gestión del Conocimiento.

INTRODUCTION

The dual education model in upper secondary education promotes knowledge-building through industry-related activities. This involves considering the work context as an external learning environment, with two different places for teaching and learning: schools and industry (Araya Muñoz, 2008). This model aims to develop links between schools and their environment and a perspective of innovation in the design of learning situations.

It is, therefore, essential to understand how knowledge between the classroom and industry is modified, assimilated, and transferred to students, which is the subject of this research, considering that the processes involved need to be understood, as few studies account for the progression in knowledge construction by students or the mechanisms of knowledge transfer between the classroom and industry.

Few studies distinguish the difference between the processes of the dual modality, which could lead to deficiencies in training planning and monitoring (Villaseñor et al., 2022). It should be noted that if how knowledge is socialized, modified, and transferred between the classroom and industry is not identified, the dual modality at the upper secondary level will be distorted.

The SECI model refers to the knowledge creation and transfer process developed in knowledge management theory through four modes of knowledge conversion—socialization is where tacit knowledge is shared between people through direct social interaction.

Despite the dual model's potential benefits, its implementation at the upper secondary level faces challenges in knowledge management. The lack of knowledge management can limit students' ability to integrate theory and practice coherently, affecting their training and professional preparation. Current knowledge management practices in this model are neither documented nor understood, making it difficult to identify strengths and weaknesses and, consequently, to improve training processes.

Theoretical Framework

The origins of dual training date back to medieval Europe, when artisans trained their apprentices under the tutelage of guilds. In the 19th century, with industrialization in countries such as Germany and Austria, this strategy was adopted in manufacturing companies, combining practical training and theoretical instruction (Fuentes et al., 2023).

In Mexico, the Mexican Dual Training Model (MMFD) is an innovative educational policy that, implemented in 2013, connects the education sector with the productive sector. This model combines upper secondary technical education with practical training in companies, where students acquire 80 % of their skills in business environments and 20 % in the classroom.

Knowledge management in educational contexts involves recognizing, obtaining, generating, preserving, sharing, and applying knowledge effectively, improving access, promoting collaboration, and strengthening formal and informal learning (Nonaka & Takeuchi, 1995; Dalkir, 2013). This goes beyond managing data; it includes transmitting experiences, skills, and practical knowledge among all participants in the educational process (Alavi & Leidner, 2001; Davenport & Prusak, 1998).

Nonaka and Takeuchi's (1995) knowledge creation model highlights the interaction between implicit and explicit knowledge, leveraging it to facilitate collaborative learning and promote pedagogical innovation. In the dual model of upper secondary education, strategies are developed to improve knowledge transfer between educational institutions and companies, integrating theory and practice to enrich learning and prepare students for the workplace (Lentzen, 2016).

Knowledge transfer is fundamental to the dual model's success. It fosters knowledge management through continuous interaction between educational institutions and collaborating companies (Eraut, 2004). Experiential learning in the dual model encourages students to actively construct their knowledge based on Vygotsky's constructivist learning theory (1978).

Nonaka and Takeuchi's (1995) knowledge spiral model describes how knowledge progresses in an upward spiral, transforming from implicit to explicit through four modes of conversion: socialization, externalization, combination, and internalization (SECI).

METHOD

Research design

A descriptive, cross-sectional, non-experimental research design was used to evaluate students' perceptions of the SECI model.

The sample consisted of 1 438 students enrolled in the fourth and sixth semesters of the dual agricultural technology baccalaureate program in Morelos, Puebla, and Veracruz.

Ethical considerations for applying the scale included ensuring the confidentiality and anonymity of the participants, obtaining their informed consent prior to data collection, and ensuring that participation was voluntary and without negative consequences. In addition, the integrity of the data was protected, and its use

was restricted to research purposes.

Data on students' perceptions in the face-to-face and dual modalities were collected using a Likert scale. Based on the literature review for knowledge management, items were generated using the dimensions of Nonaka and Takeuchi's SECI model.

- Socialization
- Outsourcing
- Combination
- Internalization

Each statement was presented with a Likert-type rating scale ranging from "Always" to "Never," including intermediate grades, concerning the statement.

Validation by expert judges

The questionnaire with the statements to be judged was prepared. The questionnaire was sent to the experts, providing clear instructions on how to make the judgment, including information on the purpose, guidelines for evaluating the questions, and the importance of providing detailed comments.

Pilot study

The participants in the pilot study were second and fourth-semester students (23 students) in the dual model of CBTA 71 in Tlalnepantla, Morelos. The wording of the items was modified to make them more understandable for the target population, and the number of items per dimension was adjusted to ensure a balanced number of items in each dimension.

RESULTS

Regarding the distribution of participants by educational modality, 92 % (1 324 students) of the 1 438 students surveyed belong to the face-to-face or school-based modality. The remaining 8 % (114 students) are part of the dual-modality.

Based on this analysis, it was determined that most items had an adequate distribution, with no significant evidence of bias. A discrimination test was also carried out to assess the ability of each item to distinguish between students with different levels of perception about knowledge management. The results indicated that all items were discriminating.

In addition, an asymmetry and kurtosis analysis was carried out for each of the items in order to assess the behavior of the distributions. However, when calculating the coefficient of variation of the items, two items that exceeded the 30 % threshold were identified, indicating excessive variability in the responses; due to this high variability, these two items were omitted from the final analysis to ensure the consistency and reliability of the instrument.

Exploratory factor analysis

The first composite component of 14 items has an eigenvalue of 21,376, explaining 47,503 % of the total variance. The second composite component of 14 items has an eigenvalue of 1,923 and explains an additional 4,274 % of the variance, bringing the cumulative percentage of variance to 51,777 %. The third component, which has 10 elements, has an eigenvalue of 1,462, contributing 3,248 % of the variance, bringing the cumulative percentage of variance explained to 55,025 %. Finally, the fourth component, composed of five elements, has an eigenvalue of 1,110, explaining 2,567 % of the variance, reaching 57,492 % of the cumulative variance.

Of a total of 43 items, the first factor is composed of 14 items that reflect the practical application of technical knowledge and the integration of theory and practice—factor 2 groups 14 items related to knowledge sharing and collaboration among students. Factor 3, with 10 items, is associated with acquiring technical knowledge through direct experience and the "learning by doing" methodology. The fourth factor, with five items, focuses on the guidance and experience tutors and teachers provide.

Table 1. Factor 1. Generating and applying knowledge, Crombach's alpha: 0,943

Items	Weight factor
23The activities in my technical training allow me to receive constructive feedback.	0,489
24The knowledge acquired in my technical training allows me to solve problems in other subjects.	0,545
25The results obtained from research are shared at school.	0,570
26My technical training encourages research to generate new knowledge.	0,534
28The practical experience in my technical training helps me enrich my academic work at school.	0,575

29The examples and real-life cases in my technical training help me apply the knowledge I have acquired in real-world situations.	0,649
30In your technical training, you acquire technical knowledge that can be applied in real-world situations.	0,651
31The activities in the professional component integrate technical knowledge with theoretical concepts.	0,648
32The information I obtain in my technical training activities allows me to identify connections between technical concepts.	0,661
33The activities in the professional component help me generate new ideas for addressing technical challenges.	0,631
34The practical experience in the professional component activities allows me to make decisions in different contexts.	0,607
35What I learn in the professional component practices allows me to approach problems creatively.	0,577
36I share what I learn in other subjects in the professional component activities.	0,559
41I apply the knowledge learned in other subjects in the professional component practices.	0,503

Table 2. Factor 2: Knowledge sharing, Crombach's alpha: 0,933

Items	Weight factor
4During my technical training activities, I share my knowledge.	0,527
9My technical training activities promote discussion on any topic that interests me.	0,415
10In my technical training activities, I exchange knowledge with my classmates.	0,670
11In the professional component activities, I exchange knowledge with my classmates.	0,687
12I share what I learn in other subjects in this subject and in the professional component practical sessions.	0,639
13I share what I learn in my technical training in class.	0, 670
14I share knowledge from other subjects in my technical training activities.	0,637
15The feedback I receive in the professional component activities improves the quality of my technical training.	0,428
16I share technical knowledge in the professional component activities.	0,556
17Thanks to the activities in my technical training, I contribute ideas in my classes.	0,678
19In my technical training, I express my ideas to understand technical topics.	0,640
20In my technical training, I discuss my experiences with other people.	0,632
21I explain technical procedures that I have learned in the professional component activities to other classmates.	0,583
27I share technical knowledge in other subjects.	0,518

Table 3. Factor 3: Acquiring and applying knowledge, Crombach's alpha: 0,919

Items	Weight factor
37The school provides me with guidance from a tutor.	0,511
38The activities in the professional component of the program help me acquire technical knowledge.	0,559
39School activities help me acquire technical knowledge.	0,593
40I apply the knowledge I have learned in the professional component of my technical training.	0,520
42The knowledge I have acquired in the professional component and in other subjects enables me to complete my disciplinary project.	0,501
43Activities in other subjects (geometry, English, ethics, among others) promote reflection.	0,556
44I put what I learn in class into practice in the professional component.	0,522
45I "learn by doing" in my subjects.	0,736
46I "learn by doing" in the professional component activities.	0,731
47Thanks to the activities in the subjects, I contribute ideas to the professional component.	0,551

Table 4. Factor 4: Content tutoring, Crombach's alpha: 0,791

Items	Weight factor
1In the professional component activities, I receive training under the guidance of a tutor or teacher.	0,700
2In the professional component activities, a tutor or teacher shares their technical experience with me.	0,713
3The teacher of basic subjects (algebra, biology, etc.) shares their technical experience with me.	0,596
5I only share what I learn in the professional component activities within those activities.	0,533
8The activities in my technical training promote reflection and analysis in the activities to be carried out.	0,525

Student's t-tests for independent samples were performed to compare the means of the factors in relation to the participants' different demographic and contextual variables.

When performing the Student's t-test for independent samples of the factors with the educational modality, as shown in the following graph, statistically significant differences were revealed, which are detailed below in two of the four factors evaluated, specifically in the factor of knowledge acquisition and application (factor 3) and in the factor of content tutoring (factor 4).

When performing the Student's t-test for independent samples of the factors with the modality, even more significant differences were found, with a p-value of 0,005 and a t-value of -2,822. This indicates that students perceive the support and guidance they receive from teachers differently depending on the modality.

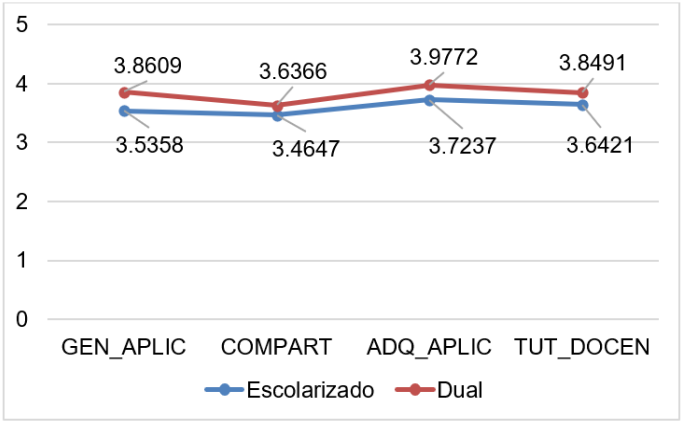

Figure 1. Comparison of means by factor in CBTA population by modality.

When performing the Student's t-test for independent samples of the factors based on the semester attended (fourth or sixth), there were no statistically significant differences between the two groups.

When performing the Student's t-test for independent samples of the factors based on whether or not the students' families were involved in agricultural activities, there were no statistically significant differences, as shown in the following figure. With a value of p=0,309, sig=0,000 for the factor of generation and application of knowledge, p=0,08, sig=0,00 for the factor of knowledge sharing, p=2,101, sig=0,000 for the factor of acquiring and applying knowledge, and p=0,378, sig=0,002 for the factor of content tutoring.

The analysis of factors based on whether students combine work with their studies or not showed no statistically significant differences in any of the factors evaluated.

The analysis of factors based on whether students consider that they have the necessary financial resources to study showed no statistically significant differences in any of the factors evaluated.

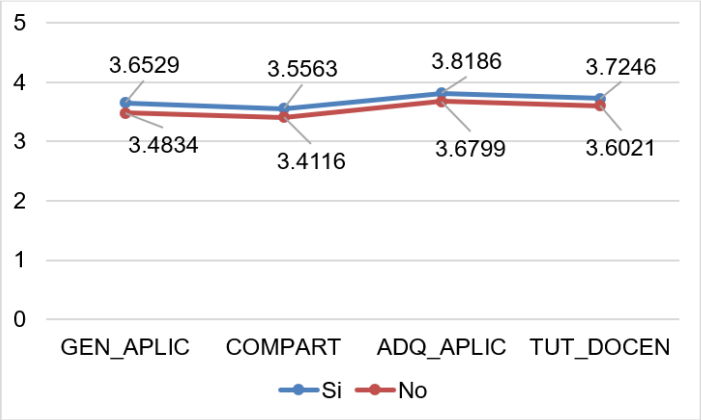

Figure 2. Comparison of means by factor in CBTA population by agricultural activities in the family

CONCLUSIONS

This research reveals statistically significant differences in the perception of knowledge management between students in school-based and dual education programs at technical educational institutions. Of the 1 438 students surveyed, 92 % belong to the school-based program and 8 % to the dual program, reflecting a

predominance of traditional education in this population. However, the results suggest that the dual modality offers an experience in knowledge generation, application, and acquisition, as well as in the perception of tutoring and teacher support.

In terms of specialization, most students concentrate on agricultural areas, while specialties such as office automation and sustainable agriculture also have a significant representation. Specializations with fewer students, such as Administration, Livestock Farming, and Industrial Food Production (PIA), have less prominent participation. This distribution suggests that areas related to the agricultural sector remain key in technical education programs, which may influence how students perceive knowledge management.

Exploratory factor analysis identified four factors that explain 57,764 % of the total variance. The first factor, related to knowledge generation and application, explained most of the variance, with 47,404 %, followed by the knowledge sharing factor, which added 4,420 %. These results highlight the importance of the practical application of knowledge and peer exchange as key dimensions in students' perception of knowledge management. Likewise, guidance from tutors and teachers also emerges as a relevant factor, although it explains a smaller proportion of the total variance.

Student's t-tests for independent samples revealed statistically significant differences in several factors, depending on the educational modality. Students in the dual modality obtained higher scores in knowledge generation and application, knowledge acquisition and application, and content tutoring. This suggests that students in the dual modality perceive more excellent teacher support and greater integration of theoretical and practical knowledge in their technical training.

Finally, analysis based on other variables, such as semester attended, families' agricultural activities, combination of work and study, and available economic resources, did not show statistically significant differences. This indicates that, regardless of these characteristics, students share similar perceptions about knowledge management in their technical training.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTION

Conceptualization: Lievanos Zeltzin, Mabel Osnaya, José Antonio Jerónimo.
Research: Lievanos Zeltzin, Mabel Osnaya, José Antonio Jerónimo.
Methodology: Lievanos Zeltzin, Mabel Osnaya, José Antonio Jerónimo.
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Original draft: Lievanos Zeltzin, Mabel Osnaya, José Antonio Jerónimo.
Revision and editing: Lievanos Zeltzin, Mabel Osnaya, José Antonio Jerónimo.