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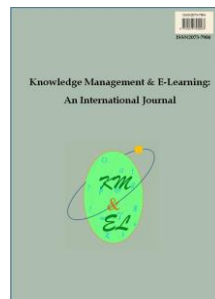
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Impact of hybrid education mechanisms on university professor's self-efficacy: Case of Moroccan universities

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Abstract: This study examines the impact of hybrid education on the self-efficacy of university professors in Morocco. Conducted during the 2021-2022 academic year, it uses an online questionnaire distributed to 102 professors, collecting demographic data and information on the perception and application of hybrid education. The research draws on the Hy Sup project and adopts a quantitative approach to assess the effect of organizational, pedagogical, and material dimensions of hybrid education on professors' self-efficacy. The data were analysed using SPSS to ensure robust statistical evaluation. The results indicate that human accompaniment and mediatization significantly impact professors' self-efficacy. At the same time, the integration of face-to-face and online phases and the mediation of learning objectives did not show significant effects. These findings highlight the need for a coherent and integrated approach in implementing hybrid education to maximize professors' self-efficacy. The study recommends enhancing continuous training, strengthening technological infrastructure, and promoting digital inclusion to improve the adoption of hybrid education. Although the sample size is limited to 102 participants, this research provides valuable insights into improving educational practices and policies in the context of hybrid education in Morocco.

Keywords: Hybrid education; self-efficacy; University professor; Covid-19

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1. Introduction

The rise of online learning technologies has transformed educational practices globally. In Morocco, proactive educational policies have been implemented to enhance human capital and improve the overall quality of education. In higher education, this evolution is evidenced by initiatives such as establishing the Moroccan Virtual Campus in 2005 and the widespread adoption of platforms like Moodle and MOOCs in most Moroccan universities (Nouib & Oulhadj, 2017). The COVID-19 pandemic accelerated this transition by compelling educational institutions to adopt distance learning methods to maintain continuity of education (Cardullo et al., 2021). Following this health crisis, hybrid education, which combines in-person and distance learning, emerged as a viable solution after the lockdown (Bounahr & ElKhattab, 2022). Although this method offers undeniable advantages, it also presents significant challenges, particularly regarding the technical and human resources required for its implementation.

Current research in the Moroccan context focuses on the impact of hybrid education on students (Halimi, 2023), while limited attention has been given to its influence on professors, especially in higher education (Kraft et al., 2021). This gap is corroborated by the systematic study of Ashraf et al. (2021), which revealed that most research on hybrid education primarily addresses student outcomes, neglecting other key stakeholders such as policymakers and professors. Our study aims to fill this gap by exploring the impact of hybrid education on the self-efficacy of university professors in Morocco. We address the following research question: How does hybrid education impact the self-efficacy of university professors in Morocco? This issue is crucial because professors play a central role in the success of new teaching methods, and their sense of effectiveness can significantly influence their teaching approach and commitment. By adopting a quantitative approach, we seek to assess the impact of hybrid education through its organizational, pedagogical, and material dimensions on the self-efficacy of university professors. We aim to provide valuable insights to inform educational policies and improve teaching practices while contributing to the existing literature on hybrid education and professors' self-efficacy.

2. Literature review

2.1. Hybrid education

Hybrid education, an evolving pedagogical model, integrates face-to-face teaching with online learning to create a more flexible and effective learning environment. Garrison and Kanuka (2004) describe it as the seamless integration of in-person and digital interactions,

while Prinsloo and van Rooyen (2007) view it as a strategic blend of diverse technologies and pedagogies aimed at enhancing student success.

Graham and Halverson (2022) emphasize the importance of hybrid education's physical structure and pedagogical dimensions, arguing that teaching methodologies significantly impact student learning. This approach offers notable advantages, such as flexibility for students and professors, personalized learning experiences, and enhanced online collaboration (Chaeruman, 2018). However, it also presents challenges, including the need for reliable technology access, technological skill variations, and additional training and resource management for professors (Graham & Halverson, 2022). As technology continues to evolve, hybrid education requires ongoing adaptation to stay effective (Wang, 2024). In summary, while hybrid education provides promising opportunities to meet the evolving needs of higher education, substantial support and resources are essential for its successful implementation and management.

2.2. Dimension of hybrid education

Burton et al. (2011) developed a descriptive framework of hybrid education by building on the foundational work conducted by Peraya and his colleagues between 1999 and 2006. Their framework elaborates on innovative pedagogical, organizational, and material dimensions characterizing the hybrid educational process. This framework forms a hybrid education mechanism, defined as: “a social place of interaction and cooperation with its intentions, its material and symbolic functioning, and its modes of interaction” (Peraya, 1999, p.53). This clarifies that the concept of hybrid education goes beyond simply combining online and face-to-face elements, involving also organizational and pedagogical aspects to create an effective and enriching learning experience. These dimensions are:

Presence/distance articulation: This dimension focuses on how the presence and distance phases are organized and integrated into the hybrid education system. It involves the distribution of time between the two modes, the sequence of phases, the type of planned activities, and the adopted educational approach, whether transmissive, individualistic, or collaborative.

Human accompaniment: This concerns learning support, with a particular emphasis on the human accompaniment of students. This dimension includes three components: cognitive (support for knowledge-building), affective (support for learning engagement), and metacognitive (support for reflecting on one's cognitive processes).

Mediation: This dimension refers to how technology influences and transforms human behavior. It includes forms of relational mediation, which concern interpersonal interactions, and reflective mediation, which concerns critical thinking and reflection.

Mediatization: It characterizes the techno-educational environment of the hybrid education system, including the design, production, and implementation processes. This dimension concerns the choice of media, the scripting of activities, and the use of technological tools to support learning.

Degree of openness: Measures the level of freedom given to learners in structuring their learning situations. A more open system allows students to take more initiative in their learning.

These dimensions are grounded in various educational, pedagogical, and cognitive theories. Wenger's (2000) theory of situated cognition underscores the importance of learning in authentic contexts, aligning with hybrid education's presence/distance articulation dimension. This dimension aims to establish a coherent and interactive learning experience, regardless of students' physical settings.

Constructivism, as pioneered by Piaget (1970) and Vygotsky (1978), asserts that learners actively construct knowledge through engagement with their environment. Within hybrid education, the human accompaniment dimension fosters this active knowledge-building process, with professors serving as facilitators who provide methodological and metacognitive guidance to support students in their learning journey.

In summary, this theoretical framework offers a comprehensive and interconnected perspective on understanding and enhancing the effectiveness of hybrid education. It highlights the importance of harmoniously integrating online and face-to-face elements and the support and resources needed to create an enriching and effective learning experience.

2.3. Professor's self-efficacy

Self-efficacy refers to individuals' belief in their ability to perform actions necessary to achieve desired outcomes. Teacher self-efficacy can be defined as "the extent to which professors believe that they can affect student performance" (Ünal et al., 2017, p.28), highlighting professors' confidence in their ability to improve student outcomes. Symes et al. (2023) further expand on this by describing professor self-efficacy as the belief in their ability to organize and execute actions required to accomplish specific teaching tasks within given contexts. Bandura (2007) emphasizes that this confidence significantly influences not only professors' perceptions but also students' learning, academic performance, motivation, and overall effectiveness. Professors with high self-efficacy tend to exhibit better planning, organization, enthusiasm, and goal achievement (Gibson & Dembo, 1984, as cited in Bandura, 2007; Midgley et al., 1989, as cited in Bandura, 2007). They are more likely to engage actively with students, adopt innovative teaching strategies, and persist in overcoming teaching challenges (Corry & Stella, 2018; Hampton et al., 2020). Research by Zee and Koomen (2016) and Lee and Ogawa (2021) confirms that teachers confident in using technology effectively are more likely to integrate it into their teaching practice.

2.4. Impact of hybrid education on the professor's self-efficacy

Although self-efficacy has been extensively studied in traditional and online teaching contexts (Corry & Stella, 2018; Ma et al., 2021; Pressley & Ha, 2021; Cataudella et al., 2021; Baroudi & Shaya, 2022; Andreou et al., 2022), before and during the COVID-19 pandemic, research on its evolution and impact in hybrid settings remains limited (Schmid et al., 2023). It is essential to continue these investigations to understand how professors' self-efficacy evolves in hybrid contexts and to adapt support and training strategies to improve teaching quality in these complex environments.

2.4.1. Articulation and the professor's self-efficacy

There is a significant lack of studies specifically addressing the articulation between face-to-face and distance teaching phases and their impact on professors' self-efficacy. Current

research mainly focuses on the impact of technology integration in education, without delving into how time allocation, planned activities, and their importance influence professors' self-efficacy. In our study, articulation refers to organizing group activities in both face-to-face and distance phases. This pedagogical approach is widely used in traditional and online classrooms. Existing research shows that group activities are particularly beneficial for knowledge acquisition in digital environments (Moore & Anderson, 2003). However, no specific research addresses the organization of group activities in hybrid contexts. Therefore, our study will focus on this organization as a key component of articulation, aiming to assess its impact on professors' self-efficacy. This leads us to the following hypothesis: **Hypothesis (H1):** Articulation positively impacts the professor's self-efficacy.

2.4.2. Accompaniment and the professor's self-efficacy

In the context of hybrid education, human accompaniment plays a crucial role by extending beyond mere technological assistance to include cognitive, affective, and metacognitive aspects (Deschryver et al., 2014). Cognitive support aids professors in facilitating knowledge construction and processing information. Affective support aims to maintain student engagement and motivation, while metacognitive support encourages students to reflect on their learning processes and adjust their strategies.

Drawing on Bandura's theory of self-efficacy, we hypothesize that human accompaniment may serve as a source of self-efficacy for professors. Bandura posits that supportive experiences and positive feedback enhance individuals' confidence in their abilities. In the context of hybrid education, appropriate accompaniment and meaningful interactions not only facilitate student learning but may also enhance professors' self-efficacy by helping them navigate and manage the challenges of mixed teaching modes. Moreover, the integration of online collaboration tools enriches the educational experience by promoting active learning and critical reflection. However, accompaniment must extend beyond interactions with professors and technologies; peer accompaniment is also vital. When students are encouraged to support and mentor their peers, it reinforces their understanding and fosters a collaborative learning environment. This dynamic contributes to a stronger learning community and supports professors in managing their self-efficacy. Thus, by examining the impact of human accompaniment in hybrid environments, we aim to explore how this support can enhance professors' self-efficacy, aligning our hypotheses with Bandura's theoretical principles and the support dimensions identified by Deschryver et al. (2014). This leads to the following hypothesis: **Hypothesis (H2):** Accompaniment has a positive impact on a professor's self-efficacy.

2.4.3. Mediation and the professor's self-efficacy

Mediation, as defined by Peraya (2007), is a process where an artifact or tool facilitates interaction between an individual and an object (knowledge, actions, people). In our study, we specifically focus on relational mediation, which addresses interactions between individuals, and reflective mediation, related to self-reflection and metacognitive awareness. Although no research directly examines the impact of mediation on a professor's self-efficacy, our hypothesis suggests that mediation strengthens self-efficacy by improving social interactions and professional reflection. **Hypothesis (H3):** Mediation has a positive impact on a professor's self-efficacy.

2.4.4. Mediatization and the professor's self-efficacy

Research frequently examines the integration of technology in education and its impact on professors' self-efficacy. Evidence shows a strong correlation between technology use and increased self-efficacy among professors. For instance, Delcourt and Kinzie (1993, as cited in Holden & Rada, 2011) demonstrated that positive attitudes towards technology and enhanced technological skills improve its effective use in the classroom. Albion (2001, as cited in Abbitt, 2011) further supported this by finding that frequent technology use is associated with higher self-efficacy. Holden and Rada (2011) also confirmed that professors who regularly integrate technology report higher levels of self-efficacy. Despite these insights, the focus has generally been on technology integration broadly, without delving into the concept of mediatization. Unlike general technological integration, which centers on the application of technological tools, mediatization involves a more comprehensive approach that includes content transformation, learner support, meta-reflection, and assessment. This perspective aims to enrich and optimize the distance learning experience by combining technological tools with targeted pedagogical practices.

Our research aims to address this gap by exploring whether mediatization, as an integrated approach, positively influences professors' self-efficacy, offering a more nuanced understanding of teaching dynamics in hybrid environments. Thus, we propose the following hypothesis: **Hypothesis (H4):** Mediatization positively impacts professor's self-efficacy.

2.4.5. Degree of openness and the professor's self-efficacy

As cited by Deschryver et al. (2014), three main forms of openness can be distinguished: complete learner autonomy, full control by the teaching system, and a balance between learning situations defined by the learner and those defined by the teacher. Our research focuses on the freedom given to students in choosing teaching methods and activities and using external experts to complement their education. Flexibility in teaching methods and access to external resources are essential elements for creating effective learning experiences. While these aspects promote student autonomy and engagement (Butcher & Rose-Adams, 2015; Soffer et al., 2019), they also present challenges for professors, particularly regarding time management and planning (Michinov et al., 2011). Despite these benefits, there is a notable lack of studies that specifically examine how openness, particularly the freedom in pedagogical choices and the use of external resources, impacts the professor's self-efficacy.

Further research could provide valuable insights into how increased pedagogical freedom influences professors' confidence and effectiveness in hybrid educational environments. This leads to the following hypothesis: **Hypothesis (H5):** The degree of openness positively impacts professor's self-efficacy.

3. Research design

Our conceptual model (Fig. 1) aims to explain the relationships between the different dimensions of hybrid education and their influence on professors' self-efficacy. The model proposes five hypotheses (H1 to H5), each representing a direct relationship between the dimensions of hybrid education, which are the independent variables, and self-efficacy, which is the dependent variable.

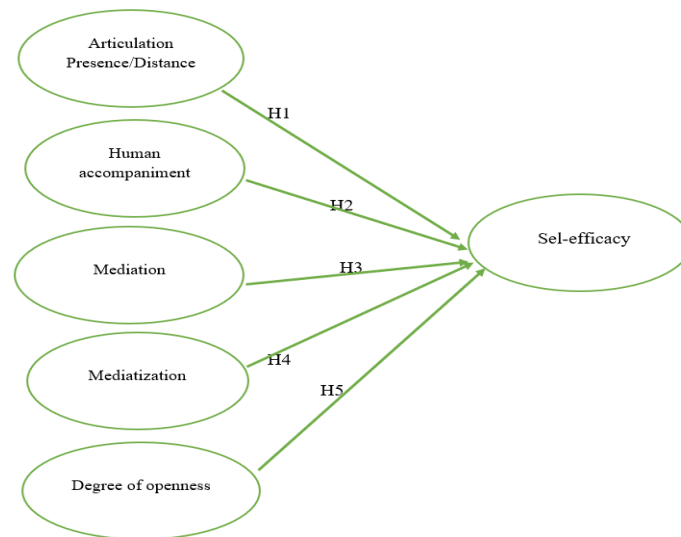


Fig. 1. Theoretical model research

4. Methods

4.1. Participants

Our study encompassed all university professors in Morocco. For sample selection, we employed a non-random sampling method, where participants voluntarily agreed to complete our questionnaire administered via Google Forms. A total of 102 participants were involved in the Survey.

The following table represents the demographic data of the participants in our study, including gender, age, professional status, and professional experience, are presented in Table 1.

The surveyed individuals represent a balanced mix of genders, with women accounting for 42% and men for 58% of the sample. The majority falls within the age bracket of 35 to 55 years. Regarding professional positions, 41% hold the title of Habilitated Professors, 29% are Assistant Professors, and 27% are Professors of Higher Education. A significant portion of the participants boast tenure ranging from 5 to 10 years, while 24% bring over two decades of experience to the table.

4.2. Procedure

This study is inspired by the work of Burton et al. (2011) conducted as part of the Hy Sup project, a research program focused on pedagogical support in hybrid higher education, aiming to identify best practices for the effective integration of digital technologies in academic environments. Our research, carried out during the 2021-2022 academic year, takes place in a context where Moroccan higher education transitioned from fully remote

learning to a hybrid model following the COVID-19 pandemic. The primary objective was to examine the impact of this shift to hybrid teaching on professors' self-efficacy.

Table 1
Descriptive characteristics of study participants

		Number	Frequency
Gender	Female	43	42%
	Male	59	58%
Age	Between 25 and 35 years	26	25%
	Between 35 and 45 years	30	29%
	Between 45 and 55 years	33	32%
	More than 55 years	13	13%
Status	Engineer	2	2%
	Habilitated professor	24	41%
	Assistant professor	30	29%
	Higher education professor	28	27%
Experience	Less than 5 years	19	19%
	Between 5 and 10 years	33	32%
	Between 10 and 15 years	19	19%
	Between 15 and 20 years	7	7%
	More than 20 years	24	24%

An online questionnaire, created using Google Forms, was employed to collect data and consisted of three sections:

Profile data collection: This section gathered detailed demographic, professional, and specialty information about university professors, providing essential context for the analysis.

Hybrid education dimension: This part explored various aspects of hybrid education, such as integrating face-to-face and remote phases, student support, techno-pedagogical mediation, and openness in the learning process, to understand how these elements were perceived and applied.

Self-efficacy: This section aimed to assess professors' self-efficacy within a hybrid framework, measuring their confidence in managing hybrid teaching and supporting students.

The questionnaire was distributed to all Moroccan university professors at the end of the first semester, over one month, using convenience sampling. It was shared via social media platforms like LinkedIn and Facebook, as well as through email, to ensure broad participation.

4.3. Measures

4.3.1. Hybrid education variable

Our study has identified and employed five main dimensions to describe hybrid education. Each dimension contains a set of components that define it. The table below outlines the dimensions used to measure this variable.

The items used in the questionnaire are presented in Table 2, each corresponding to a component that characterizes one of the dimensions of hybrid education.

Table 2

Questionnaire items and measurement scales of the variable “Hybrid education”

Dimension	Items	Measurement scales	Source
Articulation presence/distance: <i>Group activities in both face-to-face and distance phases</i>	1. You offer group activities during the in-person teaching phases (in the classroom). 2. You offer group activities during remote teaching phases (outside of the classroom).	Never-Rarely-Sometimes-Often	Charlier and Peraya (2006) Burton et al.(2011) Peraya et al. (2012) Jézégou (2014) Deschryver et al. (2014)
Human accompaniment: <i>Support from professors and peers to guide students in using teaching tools, develop their metacognitive skills, and promote collaborative learning both in front and at a distance</i>	1. You encourage student collaboration and support among peers (answering each other’s questions, providing learning resources to one another, etc.). 2. You encourage students to reflect on their knowledge and learning processes. 3. Students provide resources to their peers and answer their peers’ questions.	Never-Rarely-Sometimes-Often	Charlier and Peraya (2006) Burton et al. (2011) Peraya et al. (2012) Jézégou (2014) Deschryver et al. (2014)
Mediation: <i>Alignment of learning activities with the objectives of the course</i>	1. Your course aims to achieve learning objectives such as communication, collaboration, and self-awareness	Not at all-A little-Somewhat- very much	Charlier and Peraya (2006) Burton et al.(2011) Peraya et al. (2012) Jézégou (2014) Deschryver et al. (2014)
Mediatization: <i>Use of technologies and selection of suitable media for designing, producing, and disseminating learning resources (animations, texts, videos, platforms, Applications...).</i>	1. You provide students with tools to support learning (spaces or means for working, reflecting on their learning methods, or building their digital identity). 2. You offer students tools for communication, organization, and collaboration, such as calendars, schedules, or forums. 3. In the digital resources you provide, you include images, photos, diagrams, maps, videos, etc. 4. In their work, students include images, photos, diagrams, maps, videos, etc. 5. You use SYNCHRONOUS communication and collaboration tools (chat, video conferencing, document and screen sharing, etc.) 6. Students can comment on and modify the resources/documents provided to them and/or their peers’ work.	Never-Rarely-Sometimes-Often	Charlier and Peraya (2006) Burton et al.(2011) Peraya et al. (2012) Jézégou (2014) Deschryver et al. (2014)
Degree of openness: <i>Flexibility and adaptability in the design of learning activities allow students to choose from a variety of options, which promotes their autonomy and commitment, thus, the integration of external experts also enriches the experience by bringing varied perspectives and specialized knowledge, thereby broadening the understanding of students.</i>	1. Your course provides students with choices regarding learning activities, media and tools, methods, and more. 2. You involve external experts or resources outside the academic world in your course.	No choice- Limited choice- Significant choice- Extensive choice Never-Rarely-Sometimes-Often	Charlier and Peraya (2006) Burton et al.(2011) Peraya et al. (2012) Jézégou (2014) Deschryver et al. (2014)

4.3.2. Self-efficacy variable

The professor's self-efficacy in hybrid education reflects their confidence and perception of their ability to succeed in this teaching mode, as outlined in five specific items in Table 3.

Table 3

Questionnaire items and measurement scales of the variable "Self-efficacy"

Variable	Items	Measurement scales	Source
Self-efficacy: <i>the ability to solve problems specific to hybrid education, maintain educational intentions despite challenges, manage unexpected situations, navigate sensitive scenarios, and access the resources needed to overcome obstacles.</i>	1. Following this course, I will be able to more easily solve the problems I encounter in other hybrid courses. 2. After implementing this course, it is easier for me to maintain my intentions and achieve my teaching goals. 3. In preparation for conducting a future hybrid course, I have more confidence in handling unexpected events effectively. 4. Thanks to my skills, I can manage a greater number of challenging situations in similar courses. 5. If I encounter a problem related to this type of course in the future, I will have more resources to address it.	No-Rather No-Rather Yes-Yes	Burton et al. (2011) Bandura (2007)

5. Methods of data analysis

Following data collection, SPSS software was utilized for data analysis. Exploratory factor analysis was performed to refine item selection and assess the homogeneity of the data. Reliability testing was conducted using Cronbach's alpha coefficient to ensure the consistency and reliability of the measurement tools.

5.1. Validation test results for the variable instruments

Examination of the reliability and validity of the explanatory variables within the model before item refinement

Table 4 shows the results of reliability and validity analyses, including Cronbach's Alpha, Communalities, KMO (Kaiser-Meyer-Olkin), and Bartlett's test.

In our investigation, Bartlett's test of sphericity produced statistically significant results at the 0.05 significance level for all variables in the model. The obtained *p*-values were well below 0.05, signifying robust internal consistency among the items. The Kaiser-Meyer-Olkin (KMO) values for all variables surpassed the minimum threshold of 0.5, indicating adequate sampling adequacy. Regarding communality, theoretical guidelines recommend eliminating items with communality below 0.4 to ensure adequate representation. In our study, all communality values exceeded this threshold, necessitating no removal or modification of items for this variable.

For the reliability analysis of the measurement of model variables, we observed a satisfactory Cronbach's alpha exceeding 0.6 for all variables in our model, except for the

‘Degree of Openness’ variable. Therefore, it is advisable to exclude this variable from the model analysis to avoid any bias in the results.

Table 4

Validity analysis of the variable measurement scale

Variables	Items	Communalities ^a	KMO ^b	Sig Bartlett ^c	Alpha de Cronbach ^d
Articulation	Articulation1	0,757	0,500	0,000	0,680
	Articulation2	0,757			
Mediatization	Mediatization	1,000	1,000	0,000	1,000
Mediation	Mediation1	0,759	0,662	0,000	0,695
	Mediation2	0,699			
	Mediation3	0,691			
	Mediation4	0,749			
	Mediation5	0,604			
	Mediation6	0,717			
	Mediation7	0,759			
Accompaniment	Accompaniment 1	0,697	0,662	0,000	0,750
	Accompaniment 2	0,592			
	Accompaniment 3	0,715			
Degree of openness	Degree of openness 1	0,683	0.500	0.000	0.423
	Degree of openness 2	0,683			
Self-efficacy	Self-efficacy1	0,580	0,790	0,000	0,872
	Self-efficacy2	0,642			
	Self-efficacy3	0,701			
	Self-efficacy4	0,659			
	Self-efficacy5	0,744			

Note. a: the coefficient is significant if ≥ 0.4 ; b: the coefficient is significant if ≥ 0.4 ; c: the coefficient is significant at the threshold de 0.05; d: the coefficient is significant if ≥ 0.6

5.2. Analysis of the research model

Factor analysis of variables.

Before validating hypotheses, it is crucial to streamline the item count and categorize them into factors that yield the most informative insights. To accomplish this, we opted to utilize principal component factor analysis (PCA) (Table 5). This method allows us to group items within each variable of our model into factors, which we will subsequently employ in the linear regression analysis to confirm the hypotheses.

The factor analysis effectively identified statistically reliable factors for each variable in the model. These factors will act as replacements for the original set of measurement items for each respective variable.

The cumulative proportion of total variance explained by all factors exceeds 1, with each factor restoring over 60% of the total information. This result suggests that the identified factors for each variable are substantial and strongly representative of the measurement items. Consequently, these factors can be employed as latent variables in our multiple linear regression analysis model.

Table 5
Results of factor analyses of model variables

Model variables		Number of Items	Number of factors identified	Total variance ^a	Percentage of information provided by factor ^b
Independent Variable	Articulation	2 Items	1 factor	1,515*	75,735%
	Mediatization	7 Items	3 f factors	5,044	72,050%
	Accompaniment	3 Items	1 f factor	2,004	66,789%
Dependent Variable	Self-efficacy	5 Items	1 factor	3,326	66,515%

Note. a: the value is significant from 1; b: the value must exceed 50%

5.3. Empirical validation of the prerequisites for employing multiple linear regression

5.3.1. Analysis of multicollinearity

The Variance Inflation Factor (VIF) acts as an indicator for detecting multicollinearity among explanatory variables (Table 6). Elevated VIF values indicate the presence of multicollinearity, and to alleviate concerns, the VIF should not surpass a threshold of 5.

Table 6
Multicollinearity test

Variables	VIF ^a
Mediation	1,015
Articulation	1,071
Mediatization	1,114
Accompaniment	1,129

Note. a: the value is significant at the threshold of 5

In our scenario, all the explanatory variables have VIF values below 5, indicating the absence of multicollinearity among the variables. Therefore, we can affirm that the first condition for using linear regression is satisfied.

5.3.2. Test of independence of errors

The results of the test of independence of errors, as measured by the Durbin-Watson statistic, are presented in Table 7.

Table 7
Test of independence of errors

Durbin Watson ^a	2,432
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Note. a: the value is significant between: 1 < and > 3

The examination for error independence is performed using the Durbin-Watson test, producing a value within the accepted range of 1 to 3. In our particular case, the obtained value falls within this range, as detailed in the table above. Hence, we can infer

that there are no concerns regarding the independence of errors for the measurement variables.

5.3.3. Test of normality and homoscedasticity

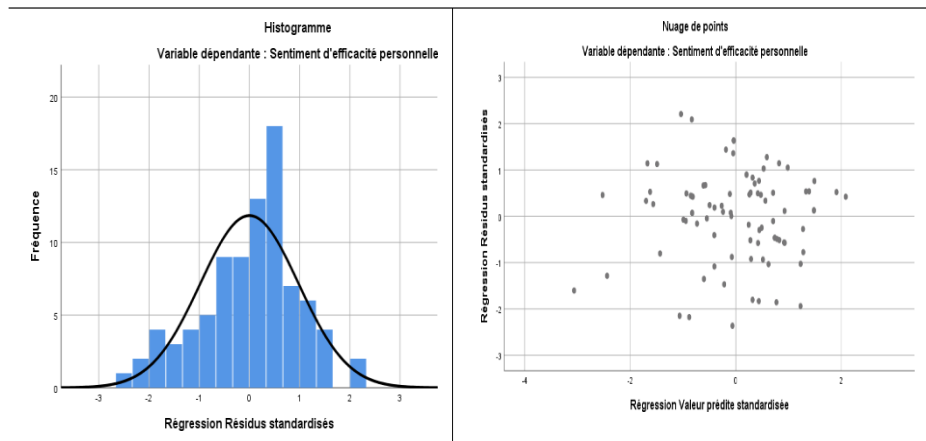


Fig. 2. Normality histogram

Fig. 3. Test of homoscedasticity

Examining the histograms in Fig. 2, it is evident that the distribution of residual values closely mirrors a normal “bell” curve, with the values aligning well with the curve. This observation suggests that the error distributions follow a normal pattern. In Fig. 3, the representation of errors scattering randomly around zero concerning predicted errors from the regression indicates consistent variance.

The assessment of conditions necessary for the application of the regression model yielded satisfactory results. We have verified adherence to the four conditions of multicollinearity, homoscedasticity, independence of errors, and normality of the data. Consequently, we can proceed to apply the multiple linear regression model.

5.4. Implementation of the regression model and examination of the research hypotheses

5.4.1. The linear regression analysis

The results of the linear regression analysis are presented in Table 8.

The examination of the coefficient of determination (R^2) provides insight into the explanatory strength of the independent variables within the model. The results indicate that, collectively, the variables (mediatization, articulation, mediation, and accompaniment) moderately explain the variance in the dependent variable (self-efficacy), contributing to 25% of the variance with an R^2 value of 0.256. Moreover, the ANOVA variance test reveals a statistically significant model with a p -value threshold of < 0.001 . This suggests that the independent variables in our model effectively contribute to the observed variation in the dependent variable (self-efficacy).

Table 8

Estimation of the model of the variable Sense of self-efficacy

	Coefficients Beta (β)	Sig: (p -value)
Articulation	0,002	0,984
Accompaniment	0,316	0,002 ^b
Mediation	-0,079	0,415
Mediatization	0,308	0,003 ^b
R	0,506	
R^2	0,256 ^a	
ANOVA	F : 7,038; Sig: (0,000)	
Std Error	0,937	
Constant	0,567	

Note. a: acceptable at the threshold of 0.19; b: the coefficient is significant at the threshold of 0.05

5.4.2. Hypothesis analysis

Hypothesis H1: Articulation has a positive impact on the professor's self-efficacy

Result: The Beta coefficient is 0.002 with a p -value of 0.984.

Interpretation: The p -value is well above the 0.05 threshold, indicating that the impact of articulation on self-efficacy is not significant. This means that, according to your data, articulation (group activities during both in-person and remote phases) does not have a notable effect on the professor's confidence.

Hypothesis H2: Accompaniment has a positive impact on the professor's self-efficacy

Result: The Beta coefficient is 0.316 with a p -value of 0.002.

Interpretation: The p -value is below 0.05, indicating that support has a significant effect on self-efficacy. A Beta of 0.316 suggests that an increase in support (encouragement for collaboration and peer support) is associated with a 31% increase in the professor's self-efficacy.

Hypothesis H3: Mediation has a positive impact on the professor's self-efficacy

Result: The Beta coefficient is -0.079 with a p -value of 0.415.

Interpretation: The p -value exceeds 0.05, indicating that the impact of mediation on self-efficacy is not significant. The negative Beta coefficient suggests that mediation (such as setting course objectives related to communication and collaboration) might even have a slightly negative impact on self-efficacy, although this effect is very minor.

Hypothesis H4: Mediatization has a positive impact on the professor's self-efficacy

Result: The Beta coefficient is 0.308 with a p -value of 0.003.

Interpretation: The p -value is below 0.05, indicating that media provision (providing tools to support learning and communication) has a significant effect on self-efficacy. A Beta of 0.308 suggests that media provision is associated with a 30% increase in the professor's self-efficacy.

5.4.3. Summary of hypothesis analysis results

A summary of the findings based on these results is presented in Table 9.

Table 9

Summaries of research hypothesis testing results

Research hypothesis	Validation
Hypothesis 1: Articulation has a positive impact on professors' self-efficacy	Rejected
Hypothesis 2: Accompaniment has a positive impact on professors' self-efficacy	Accepted
Hypothesis 3: Mediation has a positive impact on professors' self-efficacy	Rejected
Hypothesis 4: Mediatization has a positive impact on professors' self-efficacy	Accepted

6. Descriptive results by items

6.1. Hybrid education

6.1.1. Articulation presence/distance

Descriptive results concerning the dimension of articulation between in-person and remote phases of hybrid education show a varied trend in professor's responses. For the first item, which relates to offering group activities during in-person education phases, the responses are as follows: 29% of professors never offer these activities, 20% do so rarely, 32% sometimes, and 21% often. This indicates some diversity in integrating group activities during in-person classes, with a majority (53%) of professors offering them sometimes or often, but also a notable proportion (49%) offering them rarely or never.

Regarding the second item (Fig. 4), related to group activities during remote education phases, the distribution is as follows: 20% of professors never offer these activities, 19% do so rarely, 30% sometimes, and 33% often. These results show that, unlike in-person phases, a higher proportion of professors (63%) offer group activities during remote classes sometimes or often, while 39% do so rarely or never.

In summary, although group activities are more frequently integrated during remote phases, there is still significant variation in their frequency of application during in-person phases. This suggests that the integration of group activities is perceived differently depending on the mode of teaching, with a stronger tendency to use them in remote teaching contexts.

6.1.2. Human accompaniment

The descriptive results regarding the dimension of human support in hybrid education reveal interesting trends in the practices of both professors and students (Fig. 5). For the first item, which concerns encouraging student collaboration (such as answering each other's questions and providing learning resources), the responses are as follows: 6% of professors never do this, 15% do it rarely, 45% do it sometimes, and 36% do it often. These results show a predominant tendency to encourage student collaboration, with a majority

(81%) of professors engaging in this practice sometimes or often, although a minority (21%) do so rarely or never.

Articulation Presence/Distance

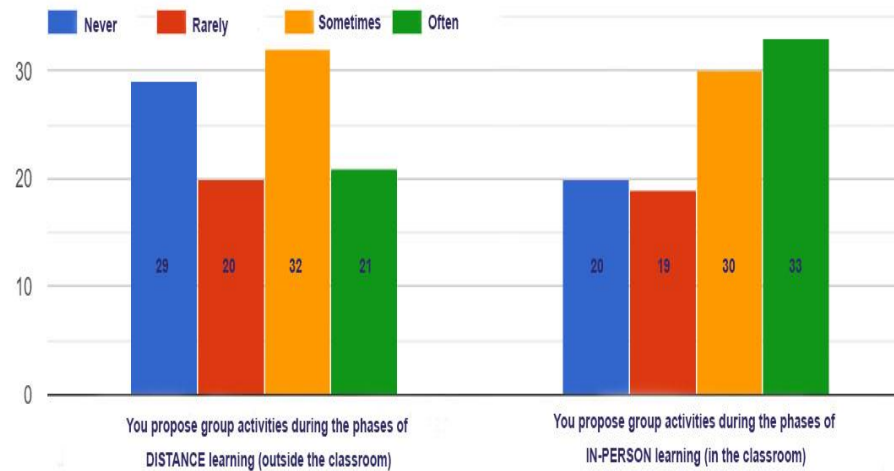


Fig. 4. Articulation presence/distance

Accompaniment provided to students in-person and distance

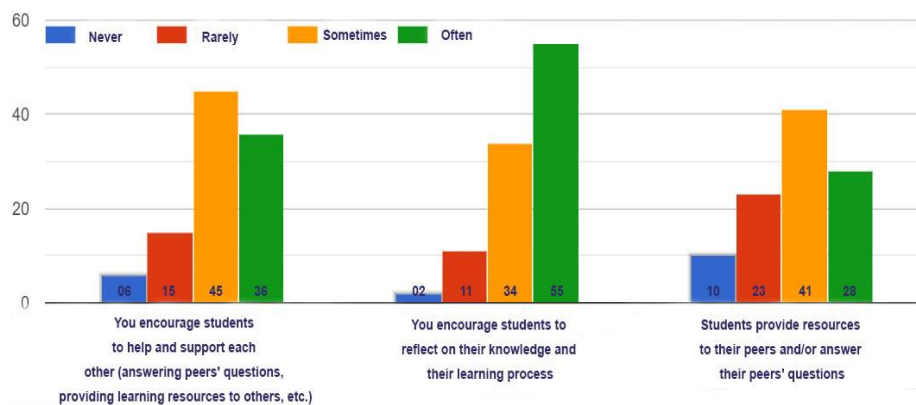


Fig. 5. Human accompaniment

For the second item, regarding encouraging students to reflect on their knowledge and learning processes, the results are very positive: only 2% of professors never do this, 11% do it rarely, 34% do it sometimes, and 55% do it often. These figures indicate that

most professors regularly encourage students to reflect on their learning, with a strong majority (89%) doing so sometimes or often.

Regarding the third item, where students provide resources and answer their peers' questions, the responses are: 10% of professors never observe this, 23% observe it rarely, 41% observe it sometimes, and 28% observe it often. These results show that most professors see students helping each other sometimes or often, though 33% of professors observe this practice rarely or never.

In summary, the results indicate that human accompaniment and student collaboration are well integrated into hybrid education, with a strong tendency to encourage these practices, especially in terms of promoting reflection on learning. However, there are variations in how frequently these supportive activities are observed, which might reflect differences in implementation or student engagement.

6.1.3. Mediation



Fig. 6. Mediation

The results for the single item in the mediation dimension (Fig. 6), which assesses how well the course aims to achieve learning objectives such as communication, collaboration, and self-awareness, show an interesting distribution of responses. Specifically, 12% of professors believe that their course does not aim to achieve these objectives at all, while 29% indicate that this happens rarely. Additionally, 29% of professors feel that these objectives are achieved sometimes, and 32% believe that this is done often.

These results suggest that while some courses may pay limited or sporadic attention to communication, collaboration, and self-awareness objectives, a significant proportion of respondents (61%) consider that these objectives are achieved sometimes or often. This reflects a general trend towards integrating these aspects into teaching, but also indicates variability in how these objectives are implemented and perceived by professors.

6.1.4. Mediatization

The results for the media dimension in hybrid education reveal a diverse use of digital tools by professors. Regarding the provision of tools to support learning, such as workspaces,

methods for reflecting on learning processes (Fig. 7), and building digital identity, a notable majority of professors (48%) never use these tools, while only 11% use them frequently. This distribution suggests that although some educators are integrating these tools, a significant portion appears hesitant or has not fully embraced these practices.

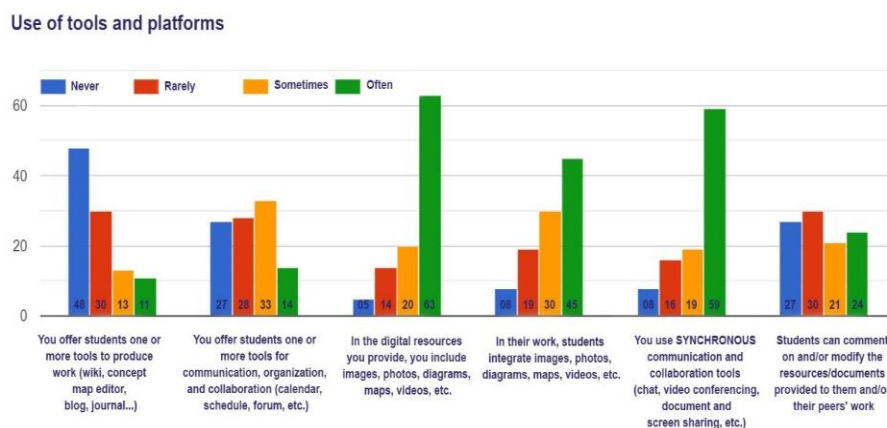


Fig. 7. Mediatization

For tools related to communication, organization, and collaboration, such as calendars and forums, 27% of professors never provide them to students, while 14% do so frequently. This indicates a moderate adoption of these tools, with room to enhance the integration of collaborative supports to facilitate interaction and manage learning.

Regarding the inclusion of multimedia content in educational resources, such as images, photos, diagrams, maps, and videos, 63% of respondents use these elements frequently, reflecting a strong trend towards enriching teaching materials with visual elements. In contrast, a minority (5%) never uses them, indicating a disparity in multimedia resource usage.

Regarding students incorporating media into their work, 45% of professors report this happens often, while 8% say it never occurs. This shows that while integrating media into student work is relatively common, it is not yet universal.

For synchronous communication and collaboration tools, such as chats and video conferencing, 27% of professors never use them, while 24% use them frequently. This indicates varied adoption of these technologies, suggesting that while some educators leverage the benefits of real-time interactions, others are still hesitant to integrate these tools into their teaching.

Finally, regarding the ability for students to comment on and modify resources and peer work, 27% of professors never allow this interaction, while 24% do so frequently. This highlights diversity in feedback and student interaction practices, with opportunities to enhance engagement and collaboration within courses.

6.2. Professor's self-efficacy

The descriptive statistics on professors' perceptions of the effects of hybrid education after a first post-COVID-19 experience show a general tendency to view hybrid courses as beneficial for their sense of self-efficacy (Fig. 8). Specifically, 52.9% of respondents

believe that this experience has enhanced their ability to solve potential problems in future hybrid courses, although 31.4% remain sceptical. Additionally, 49.0% of participants feel that hybrid courses have helped them maintain their intentions and achieve their teaching goals. Nearly 52% of respondents report increased confidence in preparing for future hybrid courses and managing unforeseen events, while 13.7% remain doubtful. Moreover, almost 54% of respondents think that the course will enable them to handle more challenging situations, with 12.7% still unconvinced. Finally, about 51% of respondents feel they have more resources to address future problems related to hybrid courses, although 18.6% are sceptical. These results suggest that while hybrid courses are generally viewed positively, there are notable variations in perceptions and individual experiences among professors.

Provide your spontaneous responses to the following statements

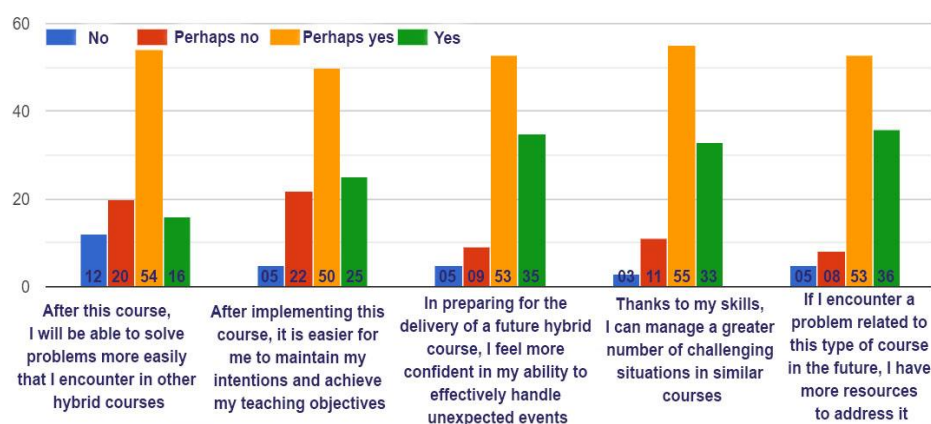


Fig. 8. Professors' self-efficacy

7. Discussion

The absence of a significant effect of integrating face-to-face and online phases on professors' self-efficacy (p -value = 0.984) could indicate a lack of consistency in applying pedagogical strategies. This observation aligns with Wenger's theory of situated cognition, which emphasizes that learning is most effective when it occurs within authentic and coherent contexts. The disconnect between in-person and online learning in hybrid education suggests that these phases may not be sufficiently integrated to create a unified learning experience, potentially limiting their impact on a professor's self-efficacy. To boost self-efficacy, efforts should be directed toward ensuring seamless transitions and interactions between the different phases of hybrid education, maintaining coherence and support in the learning environment, whether in-person or online.

Regarding accompaniment, the significant effect on self-efficacy (Beta = 0.316, p -value = 0.002) supports the constructivist perspective, which holds that learners actively construct knowledge through their interactions with the environment. In this setting, professors act as facilitators, providing essential methodological and metacognitive support. The notable impact of human accompaniment on self-efficacy indicates that when

professors encourage collaboration and reflective thinking, students are better able to engage deeply in their learning. This, in turn, increases professors' confidence in their ability to support learning within a hybrid format, reaffirming the constructivist view that active engagement and social interaction are critical components of effective learning and self-efficacy development.

On the other hand, the non-significant effect of learning objective mediation (p -value = 0.415) suggests that integrating these objectives may not yet be systematic enough to influence professors' self-efficacy. This outcome resonates with Bandura's (1978) concept of mastery experiences, implying that without structured and consistent mediation of learning objectives, professors may not feel adequately supported in guiding students toward mastery, which could hinder their sense of efficacy.

Finally, the significant impact of mediatization (p -value = 0.003) highlights the positive role that multimedia resources can play in boosting self-efficacy. This finding is consistent with constructivist principles, as multimedia tools can offer varied and engaging ways for students to interact with content and for professors to facilitate learning. However, the uneven adoption of digital tools underscores the ongoing need for consistent integration across hybrid education environments. Ensuring that professors have the necessary digital skills and resources will be crucial for fully realizing the benefits of mediatization on self-efficacy, as noted by García-Martín et al. (2023) and Richter and Idleman (2017).

These findings underscore the importance of a cohesive and supportive approach across the various dimensions of hybrid education to optimize professors' self-efficacy. Drawing on these educational theories, universities can craft more effective strategies for integrating technology with pedagogy, thereby enhancing the hybrid learning experience.

8. Conclusion

This study shows that hybrid education generally has a positive impact on the self-efficacy of university professors in Morocco, providing valuable insights for improving educational practices and developing effective policies. For a successful adoption of technology in education, it is crucial to go beyond merely providing technological tools and also address professor's pedagogical beliefs. These beliefs significantly influence their attitude towards technology. professors who prefer traditional methods may view technology as unnecessary or intrusive. To maximize the benefits of technological tools, it is essential to evolve pedagogical beliefs to embrace modern educational approaches, such as interactive, collaborative, and self-directed learning.

The Moroccan academic context, characterized by linguistic and cultural diversity, challenges related to technological infrastructure, and teaching traditions centered on face-to-face instruction, significantly affects the effectiveness of hybrid education. To optimize this approach, it is crucial to enhance ongoing faculty training, strengthen technological infrastructure, develop suitable teaching resources, and promote digital inclusion policies. Universities should consider strategies such as continuing education sessions, mentoring programs, and technology platforms to facilitate communication and collaboration.

It is important to note that the study's results may vary depending on the respondents' profiles, with the majority coming from scientific and management disciplines. Including more professors from literary disciplines in future studies could provide a broader perspective. Additionally, increasing the sample size could improve the

generalizability of the results. Longitudinal and qualitative studies could further explore the impact of hybrid education on professors' self-efficacy over time. Expanding this research to other geographical or cultural contexts would enable cross-cultural comparisons and deepen the understanding of factors influencing the effectiveness of hybrid education.

Finally, despite efforts to reach a broad audience, the study faced challenges such as a relatively small sample size (102 responses) and constraints related to remote data collection. These limitations may have affected the response rate, but the data collected provided valuable insights into the mechanisms and impacts of hybrid education on university professors.

Author Statement

The authors declare that there is no conflict of interest.

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