

PAPER

How to Motivate Engineering Education Faculty for Instructional Innovation: The Digital Leadership Effectiveness Test

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ABSTRACT

Faculty instructional innovation is the driving force behind engineering education reform and an important guarantee to promote the modernization of engineering education. With the advent of the digital era, digital leadership has become a key factor in encouraging faculty instructional innovation. Therefore, based on resource conservation theory and social cognition theory, this study explores the relationship between digital leadership, digital self-efficacy, and engineering education faculty instructional innovation and analyzes the mediating role of digital self-efficacy. Through the analysis of 316 valid samples, the results show that digital leadership and digital self-efficacy have a significant positive impact on engineering education faculty instructional innovation. Digital leadership also has a significant positive impact on digital self-efficacy, and digital self-efficacy plays a mediating role in the effect of digital leadership on engineering education faculty instructional innovation. This study reveals the impact and mechanism of digital leadership on engineering education faculty instructional innovation and provides empirical support for improving faculty instructional innovation in engineering education.

KEYWORDS

engineering education, digital leadership, digital self-efficacy, faculty instructional innovation

1 INTRODUCTION

Amidst the swift advancement of digital technologies, the education industry is undergoing unprecedented changes. The empowerment of digital technology has emerged as a pivotal catalyst for the high-quality advancement of education. As an important part of the national education system, engineering education is an indispensable component of building a high-quality education system. For a long time, engineering education instructional reform has been at the forefront of higher education personnel training reform. Therefore, promoting the digital transformation of engineering education has become an important issue in current

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education reform and development. The essential factor for the superior growth of digital-enabled engineering education is enhancing the instructional innovation capabilities of engineering faculty, thereby fostering their willingness to engage in the digital transformation of education.

Faculty instructional innovation refers to the practice of faculty in instruction aimed at the better growth and development of students constantly forming new instructional concepts, updating instructional content, using new instructional methods and means, and improving the instructional effectiveness [1]. In the digital era, faculty instructional innovation not only depends on traditional instructional abilities but is also influenced by digital tools and technologies. In the digital environment, the faculty's digital self-efficacy can enhance their self-awareness and confidence in mastering technology, which has become an important factor affecting faculty instructional innovation. Whether faculty can effectively use digital technology and explore new instructional methods and means will directly affect the quality of instruction and the learning outcomes of students.

Digital leadership denotes the capacity of leaders to leverage various digital resources to shape the attitudes, emotions, and behaviors of organizational members, with the objective of facilitating digital transformation and addressing the challenges posed by the digital landscape [2]. Faculty instructional innovation is affected by many factors, among which digital leadership is an important one. According to existing literature, the digital leadership of education managers plays a significant role in promoting instructional reform [3], but most of the research focuses on the level of principals or education leaders. Few studies have explored how the digital leadership of education managers promotes the instructional innovation of faculty by stimulating the faculty's digital self-efficacy. Therefore, improving faculty's digital self-efficacy and promoting faculty instructional innovation through the digital leadership of educational leaders has become an important issue to address.

To sum up, based on resource conservation theory and social cognition theory, this study uses quantitative research methods to analyze the direct impact of digital leadership and digital self-efficacy on engineering education faculty instructional innovation and the direct influence of digital leadership on the digital self-efficacy of engineering education faculty. Simultaneously, it examines the mediating function of digital self-efficacy in the relationship between digital leadership and instructional innovation among engineering education faculty.

2 LITERATURE REVIEW

2.1 Digital leadership and faculty instructional innovation in engineering education

Faculty instructional innovation is affected by many factors, among which digital leadership is an important factor. According to resource conservation theory, faculty instructional innovation not only depends on individual innovation ability and intrinsic motivation [4] but also is affected by resources in the external environment [5]. As a resource, digital leadership helps faculty instructional innovation by providing digital technology support and innovation incentives. For faculty in the engineering education environment, digital leadership can promote their innovative practice in instruction by improving faculty's innovative confidence and action [6].

Digital leadership provides technical support and instructional resources for engineering education faculty, effectively reducing problems such as the lack of

resources that faculty may encounter in the process of innovation. Leaders support engineering education faculty in carrying out instructional innovation activities through digital tools, platforms, and an innovative culture, which can effectively enable faculty to more actively try new instructional methods and tools in instruction. This not only enhances the motivation for faculty instructional innovation but also promotes the enhancement of faculty instructional effectiveness [7].

Based on resource conservation theory, when engineering education faculty face the challenge of instructional innovation, their psychological state and behavior will be affected by resources. A high level of digital leadership can provide faculty with the necessary digital resources, which can stimulate the motivation of engineering education faculty to carry out instructional innovation. Therefore, digital leadership may promote faculty's innovative behavior by providing digital resource support and encouraging engineering education faculty to adopt more innovative methods and tools in instructional activities [8]. To sum up, the following assumptions are made:

H1: Digital leadership substantially enhances the faculty instructional innovation of engineering education faculty.

2.2 Digital leadership and faculty instructional innovation of engineering education

With the continuous introduction of new technologies, faculty are required to have specific psychological characteristics, that is, to believe that they have the ability to master the knowledge and skills required by innovative technologies that may appear in the future and more complex technologies [9]. This particular psychological attribute is self-efficacy, which denotes an individual's conviction in their capacity to do a task when involved in a given endeavor and constitutes a subjective evaluation and appraisal of one's ability to perform [10]. Bandura stressed that self-efficacy is a set of beliefs specific to the task and background and will continue to expand with the scope of an individual's activities [11]. Therefore, in the contemporary age, digital technology promotes the development of digital self-efficacy. Digital self-efficacy refers to a subjective evaluation and judgment of a person's ability to use digital devices to perform specific tasks [12]. These digital devices include computers, the Internet, software packages, and digital applications.

According to resource conservation theory, individuals rely on external resources to reduce pressure and enhance their abilities when facing challenges [13]. In the field of engineering education, faculty digital self-efficacy refers to the faculty's confidence in their ability to apply digital technology in the digital environment [14]. In instructional activities, faculty digital self-efficacy is deeply influenced by digital leadership. As a resource, digital leadership can help engineering education faculty better master and apply digital tools by creating a supportive environment, providing digital technology training and platform support, and fostering an innovative culture for faculty. This supportive environment includes not only the provision of technical training and tools but also encouraging faculty to try new technological methods in instruction and providing them with necessary feedback and guidance. Therefore, digital leadership can enhance the faculty's confidence and motivation in using digital technology in the instructional process by improving their digital technology skills. Through effective digital leadership, engineering education faculty can receive ongoing technical support, address issues in the digital landscape, and

enhance their digital self-efficacy in teaching practices [15]. To sum up, the following assumptions are made:

H2: Digital leadership substantially enhances the digital self-efficacy of faculty in engineering education.

2.3 Digital self-efficacy and faculty instructional innovation in engineering education

Before the concept of digital self-efficacy was proposed, many researchers noticed the impact of self-efficacy on individual innovation activities. Specific self-efficacy affects individuals' specific behaviors in a particular field [10]. Therefore, higher specific self-efficacy will have a significant impact on individuals' specific behaviors. The subsequent academic self-efficacy [16], [17], managerial self-efficacy [18], and innovative self-efficacy [19] have confirmed that they have a positive impact on innovation behavior.

According to social cognitive theory, individuals can improve their behavior through self-skill cognition, external feedback, and self-regulation. In the field of engineering education, the faculty's digital self-efficacy not only affects whether they are willing to try new instructional methods and technologies but also has a direct impact on their instructional innovation behavior [20]. Faculty possessing a robust sense of digital self-efficacy exhibit greater confidence in experimenting with novel instructional tools and technology, hence increasing the likelihood of adopting innovative instructional innovation. This is because they believe they can effectively use digital technology to solve challenges in instruction and improve instructional effectiveness in the process. The reverse is also true. Therefore, there is a close relationship between faculty's confidence in their technical ability and their instructional innovation behavior. Digital self-efficacy is essential for fostering faculty instructional innovation [21]. To sum up, the following assumptions are made:

H3: Digital self-efficacy significantly enhances faculty instructional innovation.

2.4 Mediating role of faculty's digital self-efficacy in engineering education

Social cognitive theory posits that self-efficacy is the cognitive attribute most closely related to behavior and serves as a crucial intermediary that conveys environmental influences on individual behavior [22]. That is, individual self-efficacy not only directly affects their behavior but also may play a mediating role between leadership behavior and individual behavior. As faculty members' confidence in using digital technology in the digital education environment increases digital self-efficacy may play an intermediary role between digital leadership and faculty instructional innovation behavior. When faculty members feel confident in the application of digital technology, they are more likely to adopt new instructional methods and tools, thus promoting instructional innovation.

Digital leadership enhances faculty's digital self-efficacy by providing necessary digital resources and support (such as digital technology training and platform tools). After receiving support, faculty will believe that they can successfully use these digital technologies, which in turn strengthens their motivation to innovate instructional methods. When digital leadership improves the faculty's digital self-efficacy,

faculty will more actively adopt new instructional methods and promote instructional innovation. Consequently, digital self-efficacy serves a significant mediation function between digital leadership and faculty instructional innovation behavior. The faculty's digital self-efficacy not only promotes their instructional innovation behavior but also helps them transform the support and resources provided by digital leadership into practical instructional innovation practices. To sum up, the following assumptions are made:

H4: Digital self-efficacy mediates the relationship between digital leadership and faculty instructional innovation.

3 METHOD

3.1 Instruments

The three variables of digital leadership, digital self-efficacy, and faculty instructional innovation in this study are set with reference to established scales. At the same time, they are slightly adjusted according to the specific field of engineering education to better align with the characteristics of the engineering education context. The respondents rated each item according to their actual experience in engineering education and their environment. The items on the scales are all five-point scales, where 1 means "totally disagree" and 5 means "totally agree."

Digital leadership is based on the scale by Shin [23], which includes six items, such as "leaders play a positive role in reducing the resistance to innovation brought by information technology."

Faculty instructional innovation was compiled with reference to the established scale [24], including six items, such as "making appropriate plans and schedules to implement new instructional methods."

The digital self-efficacy scale was developed with reference to the established scale [25], including three items: "solving technical problems (such as equipment problems in class) is an interesting challenge for me."

3.2 Data analysis

This study examines front-line instructors in engineering education and uses the technique of random sampling for questionnaire collection. To ensure the significance of the study, the sample size was determined to be 300 using G*Power [26]. Since some of the collected questionnaires may be incomplete, and to ensure that the final number of valid samples exceeds 300, the research team issued a total of 400 questionnaires. The survey was conducted from January to February 2025. Upon distributing the questionnaire, the researcher described the study's goal and data confidentiality to the engineering education faculty polled, ensuring their comprehension of the pertinent participation conditions.

3.3 Participants and procedures

This study uses quantitative research methods to explain natural or social phenomena by revealing the laws of objective things [27]. This study comprises

three sections: the initial section delineates the descriptive statistics of demographic variables and conducts a fundamental analysis of reliability, validity, and common method variance of the quantitative variables utilizing SPSS to ascertain the necessity of further analysis. The second part uses Amos software to conduct confirmatory factor analysis and correlation analysis on the three components of digital leadership, digital self-efficacy, and faculty instructional innovation to further confirm the best-fitting model. The third part analyzes the direct paths between variables and tests the mediating variables of the model based on resource conservation theory and social cognition theory, revealing the true relationships between the variables.

4 RESULTS

4.1 Demographic analysis

Out of 400 polled engineering education faculty, 318 questionnaires were retrieved. To ensure the quality of the survey [28], two questionnaires with incomplete data or obvious issues were carefully screened out, and 316 valid questionnaires were finally collected, with an effective recovery rate of 79%. Among the 316 engineering education faculty, 53.8% were male ($n = 170$), and 46.2% were female ($n = 146$). The sample was relatively balanced in gender. In terms of work experience, 79.7% of engineering education faculty have more than five years of experience, indicating that the engineering education faculty surveyed in this study are relatively senior teachers who have a certain voice in this field and are highly credible.

4.2 Reliability and validity

In the reliability analysis, Cronbach's alpha of digital leadership, faculty instructional innovation, and digital self-efficacy were found to be 0.938, 0.936, and 0.877, and the reliability of the overall variable was 0.915. The results show that the reliability of the questionnaire's digital leadership, faculty instructional innovation, digital self-efficacy scale, and the overall scale is good [29].

In the validity analysis, the overall data KMO was 0.934, the chi-square value was 4291.175, and the degree of freedom was 105, $P < 0.001$. Therefore, the results confirm that the questionnaire has high reliability and can be effectively analyzed [30].

4.3 Common method bias

When the variables are obtained from the same data source, that is, each questionnaire is filled out by the same person, there may be a common method deviation, resulting in the distortion of the relationship between variables. This study employed the Harman single-factor test to address the usual technique bias prior to data analysis. The results showed that the first factor accounted for 45.969% of all explanatory variables, which was less than the standard threshold of 50%, and the second and third factors also significantly explained the square deviation. This indicates that the homologous deviation is within the acceptable range, and there may not be a serious common method deviation in the data [31].

4.4 Confirmatory factor analysis

Since the digital leadership, digital self-efficacy, and faculty instructional innovation in this study mainly use structural equation analysis, it is necessary to conduct a confirmatory factor analysis on the variables.

Table 1. Convergence validity

Construct	Metrics	Standardized Factor Loadings	SMC	Composite Reliability	AVE
Digital Leadership (DL)	DL1	0.878	0.771	0.938	0.716
	DL2	0.834	0.696		
	DL3	0.836	0.699		
	DL4	0.849	0.721		
	DL5	0.835	0.697		
	DL6	0.842	0.709		
Digital Self-Efficacy (DSE)	DSE1	0.825	0.681	0.878	0.706
	DSE2	0.831	0.691		
	DSE3	0.864	0.746		
Faculty Instructional Innovation (FII)	FII1	0.841	0.707	0.937	0.711
	FII2	0.851	0.724		
	FII3	0.819	0.671		
	FII4	0.848	0.719		
	FII5	0.852	0.726		
	FII6	0.848	0.719		

According to Table 1, the results show that the composite reliability of digital leadership, digital self-efficacy, and faculty instructional innovation ranges from 0.878 to 0.938, all exceeding 0.60, which confirms that the scales of digital leadership, digital self-efficacy, and faculty instructional innovation have good reliability [32]. At the same time, the average variance extracted value was between 0.706 and 0.716, both exceeding 0.50. The results confirmed that the scales of digital leadership, digital self-efficacy, and faculty instructional innovation had good convergent validity [33].

Table 2. Convergence validity

Construct	AVE	DL	DSE	FII
DL	0.716	0.846		
DSE	0.706	0.376	0.840	
FII	0.711	0.459	0.375	0.843

Table 2 shows that the square root of each AVE (0.846, 0.840, and 0.843) is greater than the correlation of other dimensions. The results confirm that the scales of digital leadership, digital self-efficacy, and faculty instructional innovation have good discriminant validity [34].

Table 3. Model fitting degree analysis

Model	χ^2	df	χ^2/df	CFI	IFI	TLI	RMSEA
3-Factor model	129.855	87	1.493	0.988	0.988	0.986	0.04
2-Factor model (DSE+FII)	538.028	89	6.045	0.876	0.877	0.854	0.127
2-Factor model (DL+DSE)	593.89	89	6.673	0.861	0.861	0.836	0.134
2-Factor model (DL+FII)	1420.987	89	15.966	0.632	0.634	0.566	0.218
1-Factor model	1801.000	90	20.011	0.528	0.530	0.449	0.246

The fitting indices of the three-factor model ($\chi^2 = 129.855$, $DF = 87$, $\chi^2/DF = 1.493$, $CFI = 0.988$, $IFI = 0.988$, $TLI = 0.986$, and $RMSEA = 0.04$) were more in line with the research requirements than those of the two-factor and one-factor models. The results showed that the fitting effect of the three-factor model was the best. To sum up, the model proposed in this study is suitable for structural equation model analysis [35].

4.5 Structural equation model analysis

Following the recommendations of Baron and Kenny [36], we examined the direct influence of digital leadership on faculty instructional innovation, the direct impact of digital leadership on digital self-efficacy, and the direct effect of digital self-efficacy on faculty instructional innovation utilizing structural equation modeling.

Table 4. Direct path coefficient

Hypothesis	Path	Standardization Point Estimate	S.E.	C.R.	P-value	Test results
H1	FII←DL	0.238	0.056	4.026	***	supported
H2	DSE←DL	0.375	0.056	6.131	***	supported
H3	FII←DSE	0.370	0.064	5.866	***	supported

Combined with the results in Tables 2 and 4, digital leadership is significantly positively correlated with faculty instructional innovation ($r = 0.459$, $P < 0.001$), digital leadership is significantly positively correlated with digital self-efficacy ($r = 0.376$, $P < 0.001$), and digital self-efficacy is significantly positively correlated with faculty instructional innovation ($r = 0.375$, $P < 0.001$). In addition, digital leadership has a direct effect on faculty instructional innovation (standardized direct effect = 0.238), digital leadership has a direct effect on digital self-efficacy (standardized direct effect = 0.375), and digital self-efficacy has a direct effect on faculty instructional innovation (standardized direct effect = 0.370). To sum up, the results are statistically significant, and assumptions 1, 2, and 3 are supported.

4.6 Mediating analysis of teachers' digital self-efficacy

In order to study the indirect effect of digital self-efficacy, we followed Hayes' suggestion [37], used the confidence interval and bootstrap technology to expand

the sample size to 5000, with a confidence interval of 95%, and performed repeated sampling for analysis [38]. We tested whether the indirect effect was significant by calculating the confidence intervals of the lower and upper bounds [39].

Table 5. Mediating effect testing results

variables	Point Estimate	Product of Coefficients		Bootstrapping			
				Percentile 95% CI		Bias-Corrected Percentile 95% CI	
		SE	Z	Lower	Upper	Lower	Upper
Total Effects							
DL→FII	0.376	0.053	7.094	0.271	0.478	0.271	0.478
Direct Effects							
DL→FII	0.38	0.053	7.170	0.129	0.344	0.128	0.341
Indirect Effects							
DL→FII	0.138	0.035	3.943	0.076	0.212	0.081	0.221

According to Table 5, the Z value of the indirect, direct, and total effects of digital leadership on faculty instructional innovation is greater than 1.96, and the confidence interval does not contain 0 [40]. Clearly, the results confirm that digital self-efficacy has a significant mediating effect between digital leadership and faculty instructional innovation (standardized indirect effect = 0.138), so hypothesis H4 is supported.

5 DISCUSSIONS

This study's primary contribution is the proposal and validation of a theoretical model that integrates digital leadership, digital self-efficacy, and faculty instructional innovation. Although existing literature has discussed the relationship between digital leadership and faculty instructional innovation from the perspective of social cognitive theory, this study takes digital self-efficacy as a mediating variable for the first time to explore the complex relationship between digital leadership and faculty instructional innovation. The following four points will be discussed in detail according to the assumptions of the study.

First, this study verifies the important role of digital leadership in the instructional innovation of engineering education faculty and reveals that digital leadership is significantly positively correlated with the teaching innovation of teachers. This is similar to the existing research results [41], [43]. Leaders with a high level of digital leadership are skilled at using digital resources to optimize resource allocation and provide powerful support for engineering education faculty, such as digital tools, training resources, and digital instructional platforms. These supports can effectively stimulate engineering education faculty to enhance instructional innovation, which further supports resource conservation theory. As a digital resource, digital leadership can make engineering education faculty feel more supported in their instructional activities in the digital era. In a favorable digital environment, engineering education faculty are more inclined to take the initiative to carry out instructional innovation.

Second, the positive effect of digital leadership on faculty digital self-efficacy in engineering education has also been verified. This is similar to the existing research results [44]. As a digital resource, digital leadership can help faculty enhance their digital self-efficacy by providing digital technology support and related training [45] [46]. This result also further supports the resource conservation theory. When faculty in engineering education face challenges in the digital teaching environment, only with sufficient resources can they better cope with them, making them more confident.

Third, the study also found that digital self-efficacy has a significant positive impact on faculty instructional innovation in engineering education. This result is consistent with the existing literature [47], [48]. When faculty in engineering education have confidence in the application of digital technology, they are more inclined to adopt new instructional tools and methods, thus promoting instructional innovation. This finding supports the influence mechanism of self-efficacy on behavior in social cognitive theory. After the enhancement of digital self-efficacy in engineering education faculty, they not only improve their work motivation but also become more willing to try more challenging instructional methods.

Fourth, this study verifies the mediating role of digital self-efficacy between digital leadership and faculty instructional innovation. After receiving the support of digital leadership, faculty can enhance their confidence in the control of digital technology and then more actively adopt new instructional methods and technologies to promote instructional innovation. Digital self-efficacy not only directly affects individual behavior but also plays a mediating role between external factors and behavior. So, when faculty in engineering education are faced with challenges, through the support of effective digital leadership resources, their digital self-efficacy is enhanced, which promotes them to adopt innovative methods in instruction. At the same time, when faculty feel that they can successfully use digital technology, they will be more inclined to adopt new instructional methods and tools to promote instructional innovation through effective digital leadership support.

6 CONCLUSIONS

This study explores the correlation between digital leadership, digital self-efficacy, engineering education faculty instructional innovation, and the mediating role of digital self-efficacy in digital leadership and engineering education faculty instructional innovation. In this study, 316 valid samples were obtained through a questionnaire survey, followed by empirical analysis. A model was established to verify the research hypothesis, and statistical methods were applied.

The results show that both digital leadership and engineering education faculty instructional innovation, digital leadership and digital self-efficacy, and digital self-efficacy and engineering education faculty instructional innovation are positively correlated, and digital self-efficacy plays an intermediary role in digital leadership's effect on engineering education faculty instructional innovation. These findings further support the rationality of social cognition theory and resource conservation theory. The results show that there is a positive correlation between digital leadership and engineering education faculty instructional innovation, between digital leadership and digital self-efficacy, and between digital self-efficacy and engineering education faculty instructional innovation. Additionally, digital self-efficacy plays a mediating role in the effect of digital leadership on engineering education faculty instructional innovation. These findings further support the validity of social cognitive theory and resource conservation theory.

7 IMPLICATIONS FOR THEORY AND PRACTICE

Theoretically, this study reveals the correlation between digital leadership, digital self-efficacy, and engineering education faculty instructional innovation, and the mediating role of digital self-efficacy in digital leadership and engineering education faculty instructional innovation. This research enhances the study of digital leadership and faculty instructional innovation in engineering education while also broadening the application of social cognitive theory and resource conservation theory within the digital framework of engineering education.

Initially, we must strengthen the digital infrastructure of engineering education leadership and elevate the standard of digital leadership. This study revealed that digital leadership significantly influences instructional innovation among engineering education faculty. It is suggested that engineering education institutions should regularly conduct digital leadership training to improve the leadership capabilities of school leaders in the digital environment. This training should also strengthen their ability to consciously support and guide faculty in their instructional activities during the digital transformation process. By leading faculty to actively use digital tools for instructional innovation, school leaders can ensure that the quality of instruction improves throughout the digital transformation.

Second, strengthen the construction of a supportive environment and comprehensively improve the support services for faculty instructional activities. In order to promote the instructional innovation of engineering education faculty, on the one hand, leaders need to actively provide faculty with sufficient digital technology training and resources according to development needs, enabling faculty to effectively use new technologies and tools for instruction. On the other hand, a comprehensive instructional support system should be established through digital means, including a digital resource library, online learning platform, virtual laboratories, etc., to help faculty flexibly integrate digital technology into their instructional practices. At last, leaders should also establish an excellent resource platform for faculty, a digital communication platform, and a feedback mechanism. These platforms would encourage faculty to analyze their innovative instructional methods and successful achievements, promote the exchange of learning resources in engineering education, provide successful case references for more faculty, and help improve the quality and effectiveness of instruction.

Third, build a multidimensional psychological empowerment system to improve the digital self-efficacy of engineering education faculty. For one side, implement psychological empowerment training to enhance the digital cognition and self-confidence of engineering education faculty. For example, through expert lectures, case sharing, interactive discussions, and other formats, faculty are guided to correctly understand the digital technology in promoting instruction and to identify their own strengths and potential in the application of digital technology. For the other side, establish a personalized psychological counseling mechanism to alleviate the technical pressures faced by faculty. For instance, one-to-one psychological counseling services can be provided to help engineering education faculty adjust their psychological stress in a timely manner and eliminate their resistance to the application of digital technology. Additionally, the counseling mechanism should consider the individual differences among faculty members and provide targeted support to enhance their digital self-efficacy. In addition, establish a psychological incentive and feedback mechanism to recognize faculty's progress and innovative attempts in a timely manner. Their digital self-efficacy can be enhanced through material or psychological incentives. Through positive incentives, engineering

education faculty can form a positive feedback loop in the process of applying digital technology, thereby boosting their self-confidence and further promoting the deepening of instructional innovation.

8 LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Based on resource conservation theory and social cognitive theory, this study discusses the relationship between digital leadership, digital self-efficacy, and faculty instructional innovation in engineering education, providing useful theoretical and practical enlightenment for future research in this area, but there are still certain limitations that need to be further explored in future research.

Firstly, the limitations of the sample. The participants in this study are mainly engineering education faculty from China, which has certain specificity. Although the sample size is large (316 valid samples), whether the findings can be widely applied in the field of education remains to be further verified. Future research could consider covering a broader range of education types and regions to improve the external validity of the research results.

Secondly, the constraints of the cross-sectional study. This study used a cross-sectional approach, with data collection confined to a single time point, hence limiting the comprehensive investigation of causation to some degree. Subsequent studies may investigate the causal links among digital leadership, digital self-efficacy, and instructional innovation behavior utilizing a longitudinal research approach.

Thirdly, the simplification of research variables. This study mainly focuses on three core variables: digital leadership, digital self-efficacy, and faculty instructional innovation in engineering education. However, educational innovation may be influenced by many other factors, such as educational policy, cultural background, and school resources. Future research could consider introducing additional variables to further explore other factors that may affect faculty instructional innovation.

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