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Electrical Engineering Faculty's Perspectives Towards Integrating Technologies into Teaching and Learning*

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This study investigated electrical engineering faculty's perspectives towards technology integration in classrooms. A survey research method obtained professors' perceptions of technology integration. A questionnaire developed in the study consisted of four psychological constructs: development of digital learning material, digital learning technology use, school administrative support, and individual instructional perception (defined as personal barriers to technology adoption). One hundred twenty-eight electrical engineering faculty members in Taiwan participated in the study. The findings show that the overall electrical engineering professors' attitude towards technology integration in classrooms is positive. Faculty members perceive individual instructional perception, such as time investment and teaching burden, to be a major concern for integrating technologies into teaching and learning. Age and academic rank do not strongly influence their attitudes towards technology integration.

Keywords: technology integration, learning with technology, technology in engineering education

1. Introduction

For decades, educators worldwide have been considering integrating technology into classrooms in order to promote the idea of digital citizenship. In the U.S., the International Society for Technology in Education [1] developed national educational standards and performance indicators for K–12 teachers who would like to adopt technology integration. Similarly, the Scottish government [2] encouraged teachers in different school levels to incorporate digital technologies into their curriculum. Even though the technology integration approach demonstrates potential learning benefits, researchers' and educators' perspectives toward technology's role in teaching and learning environments are still diversified [3].

Proponents, such as Howland et al.'s study [4], argued that technology integration might stimulate students' learning motivations and eventually influence their learning performances. In contrast, Wachira and Keengwe pointed out that when using technologies for instructional purposes, frequent student misbehavior often disrupted teaching procedures [5]. Regarding the learning effectiveness of technology, previous empirical studies reported divergent results. A meta-analysis study conducted by Waxman et al. [6] showed that a positive effect on students' learning outcomes existed for technology integration. However, findings from Higgins et al.'s [7] study indicated that the impact of digital technologies on learning outcomes remained undetermined. Clark and Mayer [8] proposed that technology integration should focus on advancing student learning experience rather than improving students' learning outcomes.

Similar to western countries, education policymakers in Taiwan also actively promote technology integration into learning curriculum. They encourage school educators to embrace the concept of digital learning and teaching [9]. Coping with this government policy, higher education institutions have started to formulate their plans to evaluate faculty's use of digital technologies in their curriculum design. According to one college's educational report [10], college professors thought that PowerPoint embedded with imagery was their main integrated classroom technology. Extra teaching efforts in classrooms are lacking other digital technologies, such as social media and mobile technology.

Subject culture is defined as a "general set of institutionalized practices and expectations which have grown around a particular school subject [11, p. 614]." Hew and Brush [12] contended that subject

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culture was a major factor that might affect teachers' attitudes towards technology integration. Rossiter [13] observed that engineering professors at universities in the UK did not actively integrate various digital technologies into teaching and learning, perhaps as a cause of the unique subject cultures in the engineering disciplines [14]. The same phenomenon was also identified in the university where a focus group interview with the engineering faculty was conducted through a pilot study.

In recent years, two special issues of the *International Journal of Engineering Education* indicated the learning benefits of technology integration. In the special issue of current trends of e-learning in engineering education, Chen [15] indicated that the effects of information and communication technologies indeed positively influenced engineering learning and teaching. Similarly, in the special issue of emerging technologies for engineering education, Lytras et al. [16] reported that emerging technologies potentially facilitated the engineering learning process. Although previous research offered a promising outlook, empirical analysis regarding engineering instructors' attitudes towards technology integration into the classroom remained unclear in the literature.

Regarding technology integration in the field of electrical engineering education, researchers attempted to use various digital technologies to support student learning. For instance, Nortcliffe and Middleton [17] employed the technological features in smartphones to improve feedback production. Clafferty [18] used online social networking to facilitate student learning experience. Lin and Liu [19] integrated cloud computing into the classroom to achieve effective teaching practice. Whether or not other electrical engineering faculty may be willing to embrace the concept of technology integration deserves further exploration.

The research position of the current study grounds in a neutral situation. The controversial part of technology integration between two camps (i.e. proponents and opponents) was not a research focus in the study. The purpose of the research was to understand the engineering faculty's attitude towards technology integration in classrooms. We examined the research participants at a national level rather than in a single case study. Engineering professors participating in the study were recruited from eight different public research universities in Taiwan. A survey was conducted to investigate the perceptions of technology integration in the study. Specifically, the two research questions were:

1. What is the status of electrical engineering faculty's attitude towards technology integration in classrooms?
2. Does electrical engineering faculty's background information, such as age and academic position influence their attitude towards technology integration in classrooms?

2. Survey constructs

Prior to the study, we conducted a focus group interview with 10 engineering faculty members to obtain potential survey constructs. This focus group identified four major constructs used in the study: development of digital learning material, digital learning technology use, school administrative support, and individual instructional perception, which are as follows:

1. *Development of digital learning material*. Digital learning material is one form of an interactive learning resource (e.g., PowerPoint) that contains animated or static visualizations (e.g., simulations) prepared for teaching and offered for student practice after class. During the teaching preparation process, faculty members may lack expertise in developing digital learning material [20]. As a result, teachers might prefer to use conventional learning material (i.e. paper-based material) [21] in their classroom teaching.
2. *Digital learning technology use*. Alam [22] indicated that digital learning technologies, such as smartphones and tablet computers, would enhance engineering students' learning performances. When adopting digital learning technologies in classrooms, faculty members may feel pressured and become uninterested or unsure regarding the types of technologies available on the market [23]. To some extent, instructors may view digital learning technologies as incompatible for their teaching methods [24].
3. *School administrative support*. Hew and Brush [12] pointed out that schools should provide necessary resources, such as digital teaching technologies and training workshops, to fully support instructors who attempt to integrate technologies in their curricula. In addition to possible resources, schools should create an incentive plan to the faculty who will actively use digital technologies in their classrooms.
4. *Individual instructional perception*. Faculty members might perceive technology integration to be a time-consuming process [3]. Time invested in technology integration may severely influence their academic development [25]. Faculty members may underestimate their skills in technology-based pedagogy [26], resulting in a lack of confidence in promoting technology integration.

3. Research methods

3.1 Research design

This study adopted a survey methodology. Personal information was the major independent variable, including academic rank and age. The dependent variables were the faculty's perceptions on technology integration in terms of development of digital learning material, digital learning technology use, school administrative support, and individual instructional perception. Because the number of female electrical engineering professors was very low, a potential gender effect was not considered in the study.

3.2 Research instrument

We used a questionnaire named "Attitude for Integrating Technologies into Teaching and Learning" to obtain engineering faculty's perceptions of technology integration. This questionnaire consists of two parts with items scored on a 5-point Likert-type scale. The first part (personal information) consists of two questions. In the second part, each construct (factors influencing technology integration) contains four items, resulting in 16 main questions. Overall scores range from 16 to 80. High scores represent a positive attitude of the respondents' toward integrating technologies in classrooms. To increase the response reliability, all survey questions adopted a reverse-scored design. The survey design is listed in Table 1.

Before the implementation of this study, the questionnaire underwent three stages to develop the validity and reliability of the survey content. In the first stage, two engineering education experts reviewed the questions. The initial 20 items in the survey were reduced to 16 because four items seemed ambiguous. In the second stage, three other senior electrical engineering professors verified the item description. Unclear portions of the questionnaire were revised. In the last stage, the formal edition of the questionnaire was distributed to 33 engineering faculty members at a public university. At this stage, the reliability and validity of the questionnaire were examined. Table 2 lists the results of the reliability and validity tests. Overall, the reliability coefficient in each survey construct was above 0.6, indicating that the questionnaire was highly reliable [28]. A significant relationship between each construct and total scores was found, revealing that the survey can successfully measure participants' attitudes towards integrating technologies in classrooms.

3.3 Research participants

The target schools in the study were eight public research universities in Taiwan. The research participants were full-time faculty members at their respective electrical engineering departments in these universities. All participants had acquired doctoral degrees in electrical engineering related fields. According to a recent statistical report of the Ministry of Education in Taiwan [29], the number of potential research participants (total population) was 364. Based on the sampling principle suggested by Creative Research Systems [30], at least 114 research participants should be recruited at a 99% confidence level with a 10% sampling error. After a 2-month research campaign conducted using mail and Internet surveys, one hundred and twenty-eight valid questionnaires were collected. The number of research participants fulfilled the sampling requirement. Table 3 summarizes the profiles of the research participants.

Table 1. Survey design

Structure	Question Items	Question Design
Part one	2	Academic rank: 1. Assistant professor, 2. Associate professor, and 3. Full professor Age: 1. 30~40 (Below 30 included), 2. 41~50, and 3. Above 50.
Part two	16	5-point Liker-type: 1. Strongly disagree, 2. Disagree, 3. Neutral, 4. Agree, and 5. Strongly agree.

Table 2. Results of the reliability and validity tests

Survey Construct	Question Items	Reliability Coefficient	Correlation Coefficient (with total scores)
Development of digital learning material	4	0.76	0.76**
Digital learning technology use	4	0.79	0.82**
School administrative support	4	0.90	0.62**
Individual instructional perception	4	0.62	0.82**
Total	16	0.92	1

**$P < 0.01$.

Table 3. Profiles of the research participants (n = 128)

Type	Number
1. Age	
A. 30~40	40
B. 41~50	53
C. Above 50	35
2. Academic Rank	
A. Assistant professor	35
B. Associate professor	67
C. Full professor	26

3.4 Data analysis

This study used descriptive and inferential statistics to analyze the collected data. Descriptive statistics were the mean and standard deviation for each question item. In inferential statistics, one-way multivariate analysis of variance (MANOVA) was used to investigate the effects of the independent variables (personal information) on the dependent variables (faculty's perceptions towards technology integration). If a significant F value was obtained, then the Scheffe comparison method was used to perform a multiple comparison test.

4. Results

4.1 Descriptive statistics

Table 4 summarizes the mean scores and standard deviations for all of the survey constructs. Overall, the professors' attitude towards integrating technologies in classrooms was positive (mean = 3.29; standard deviation = 0.59). Although the mean score for the individual instructional perception was low, the mean scores for the other three constructs reached a medium level.

Table 5 lists the statistical details of the questionnaire items. The results indicated that the means of three survey items (1-2, 4-1, and 4-2) were lower than 3, and the means of six survey items (1-3, 1-4, 2-1, 3-2, 3-4, and 4-4) were higher than 3.5. Overall, most survey responses were positive (i.e. > 3).

4.2 Inferential statistics

The MANOVA results for age and academic rank are summarized in Tables 6 and 7. Significant differences were observed in the measures of development of digital learning material (F = 5.94, $p < 0.01$), school administrative support (F = 0.03, $p < 0.05$), and total scores (F = 5.59, $p < 0.01$) among engineering professors with different ages.

Significant differences in development of digital learning material were found between professors who were 30–40 years old and 41–50. Another difference was observed between professors who were older than 50 years old and 41–50. When four survey constructs were combined (total), a significant difference between professors older than 50 years old and 41–50 was observed. No

Table 4. Mean scores for survey constructs (n = 128)

Survey Construct	Mean	Standard Deviation
1. Development of digital learning material	3.35	0.84
2. Digital learning technology use	3.46	0.69
3. School administrative support	3.44	0.81
4. Individual instructional perception	2.92	0.80
Total	3.29	0.59

Table 5. Statistical details of questionnaire items (n = 128)

Survey Item	Mean*	Standard Deviation
1-1. I do not need to develop digital learning material because the current oral lecture is enough for my courses.	3.28	1.06
1-2. I feel that paper-based learning material is better than digital learning material in terms of instructional objectives.	2.92	1.07
1-3. My courses are not suitable for developing digital learning material.	3.58	0.91
1-4. I am not familiar with developing digital learning material.	3.63	1.01
2-1. I am not interested in emerging digital learning technologies.	3.73	0.87
2-2. I feel some pressure when integrating digital technologies into classrooms.	3.33	0.97
2-3. I am not sure what kinds of digital learning technologies are available in the market.	3.33	0.72
2-4. Appling digital learning technologies into classrooms will disturb my teaching procedures.	3.25	1.04
3-1. School does not offer extra financial support for teachers who attempt to adopt technology integration.	3.27	1.23
3-2. School does not offer workshops or training courses for technology integration in classrooms.	3.51	0.86
3-3. School does not encourage teachers' contribution on technology integration in classrooms.	3.44	0.97
3-4. School lacks of related software and hardware of technology integration.	3.60	0.93
4-1. Adopting technology integration will cost me a lot of time.	2.26	1.07
4-2. Adopting technology integration will create a burden for me.	2.49	1.01
4-3. I feel that technology integration will not benefit for my academic career.	3.34	1.09
4-4. I feel that my confidence on technology-based pedagogy is inadequate.	3.58	1.06

* Higher scores toward disagreement. Note: Digital learning material and technology were described in detail for survey respondents.

Table 6. MANOVA results by age

Survey Construct	**SS**	**DF**	**MS**	**F**	***P***	**Post Hoc**
1.Development of digital learning material	7.72	2	3.86	5.94	0.00**	A > B**, C > B**
2. Digital learning technology use	2.17	2	1.09	2.33	0.10	
3. School administrative support	4.53	2	2.26	3.58	0.03*	None
4. Individual instructional perception	2.15	2	1.08	1.70	0.19	
Total	3.65	2	1.83	5.59	0.00**	C > B**

*$p < 0.05$; ** $p < 0.01$; A: 30-40 B: 41–50 C: > 50.

Table 7. MANOVA results by academic rank

Survey Construct	**SS**	**DF**	**MS**	**F**	***P***	**Post Hoc**
1. Development of digital learning material	6.17	2	3.08	4.66	0.01**	A > B**
2. Digital learning technology use	2.11	2	1.06	2.26	0.11	
3. School administrative support	1.49	2	0.75	1.14	0.32	
4. Individual instructional perception	2.47	2	1.24	1.97	0.14	
Total	2.51	2	1.26	3.73	0.03*	None

*$p < 0.05$; ** $p < 0.01$; A: Assistant professor B: Associate professor C: Professor.

additional significant difference was identified in the post hoc analysis of school administrative support.

According to academic rank, significant differences were seen in development of digital learning material (F = 4.66, $p < 0.01$) and total scores (F = 3.73, $p < 0.01$). In development of digital learning material, a significant difference between assistant and associate professors was found. When four survey constructs were combined (total), no additional significant difference was observed in the post hoc analysis. This phenomenon would be attributed to the effect of the weak factor (i.e. academic rank) on the dependent variables [31].

5. Discussion

The results of the study indicated that the electrical engineering professors' overall attitude towards technology integration in classrooms was positive. Measures in development of digital learning material, digital learning technology use, and school administrative support were above the medium level. Faculty members who had negative responses in the individual instructional perception displayed a major concern for technology integration in classrooms [3, 25, 26]. Teachers felt challenged and burdened with spending extra time and efforts in integrating technologies into their classrooms. This might yield problems in their time allocation between teaching and research.

Engineering faculty members believed that their professional expertise was sufficient for developing digital learning materials. The resident courses that they offered at their electrical engineering departments were as useful as existing digital learning resources. In addition to face-to-face classroom lectures, developing digital learning materials for students as supplements was necessary. However, engineering professors still believed that paper-based educational materials were important. These findings are inconsistent with those obtained in previous studies, which indicated that teachers resisted changing their perception of the benefits of digital learning material [20, 24].

Faculty members were fascinated by the emerging digital teaching technologies that were available on the market. Engineering professors adopting digital learning technologies might not feel pressured but believed that integrating technologies into the curriculum did not interfere with their current teaching preparations. The school administration completely supported the teachers by continuing to offer training workshops on technology integration on a regular basis. Supportive software and hardware should be required during the technology integration process. The teachers who were willing to integrate technologies into classrooms received sufficient resources and support from the school administration [12].

In addition, the results revealed that age and academic rank swayed teachers' attitudes for development of digital learning material. Assistant professors' positive perceptions of digital learning material were significantly higher than those of associate professors. This difference was also observed between professors that were 30–40 years old and 41–50. However, faculty members who were above 50 years old had a higher positive attitude toward digital learning material and overall scores than did faculty members who were 41 to 50. In other words, engineering professors' willingness to integrate technologies in classrooms was not influenced by either age or academic rank.

Due to the limited sampling strategy used in the study, the findings only reflected engineering professors' perspectives in Taiwan and thus may not be generalized to learning environments in other countries and cultures. The following practical strategies proposed in the study would benefit engineering educators who have a desire to promote technology integration in their institutions. First, the process of implementing innovative teaching practices took longer than expected. Adequate teaching resources (e.g., hardware, software, and training) should be available on campus. Second, engineering professors integrating technologies into their classrooms innovated their curriculum design but might not automatically improve students' learning performance. Developing effective and efficient instructional strategies using technologies was necessary. Third, faculty members who invested time and efforts in technology integration needed a better reward system. School administrations should establish policies for encouraging early adopters. Reducing teaching loads and providing extra financial support were feasible incentives.

6. Conclusion

This study investigated the engineering faculty's attitude towards technology integration in the classrooms. The results indicated that the electrical engineering professors' overall attitude towards technology integration in classrooms was positive in these three areas: development of digital learning material, digital learning technology use, and school administrative support. Individual instructional perception would be a concern to the engineering professors who accepted the idea of technology integration. In the measure of individual instructional perception, professors' time allocation between teaching and research and extra teaching efforts in integrating technologies into their classrooms might affect their perceptions of technology integration. Electrical engineering faculty's attitude towards technology integration in classrooms was not influenced by their background information, such as age and academic rank. The only measurement affected by the background information was their perception in development of digital learning material.

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