

Examining the Effects of Technology-Integrated Curriculum Dimensions on Academic Performance among University Students in Shandong, China

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Abstract

The incorporation of technology into higher education curriculum is increasingly important to enhance teaching and learning. This study investigated four dimensions of Technology-Integrated Curriculum namely Balance of Curriculum, Technology and Pedagogy; Content Knowledge and Supports Meaningful Learning; Enables Differentiated Instruction; and Encourages Innovation to understand their effects on the Academic Performance of university students. The research adopted a quantitative approach to investigate four key technology-integrated curriculum dimensions which affect student engagement of university students in Shandong, China. Results showed that four dimensions positively affected Academic Performance. Content Knowledge and Supports Meaningful Learning demonstrated the strongest effect ($\beta = .278, p < .001$), followed by Balance of Curriculum, Technology, and Pedagogy ($\beta = .266, p < .001$), Encourages Innovation ($\beta = .225, p < .001$), and Enables Differentiated Instruction ($\beta = .179, p < .001$). The results of the four alternative hypotheses supported the conclusion that technology integration for meaningful learning in addition to using technology requires meaningful alignment between the curriculum, teaching, student learning differences, and innovative practices. Support for the TPACK framework was found and implications for university programs and faculty in the development of curricula and teaching practices using technology to enhance student learning were outlined. Technology-supported meaningful learning should be prioritized by universities and strengthened by alignment of pedagogy, differentiation, and innovation. Further research is suggested to examine additional variables, and greater geographical distribution.

Keywords: Academic Performance, Technology-Integrated Curriculum, University Students

Introduction

Higher education institutions across the world are experiencing profound changes as digital technologies are increasingly integrated into their curricula and pedagogies. The challenge of technology integration into teaching and learning, however, extends beyond the simple introduction of technologies into current practices of teaching and learning. Technologies and associated tools must be meaningfully aligned with curricula, pedagogies and the learning

needs of students to enhance academic outcomes. Technology-supported learning has the potential to improve educational outcomes for students in China (Abbey et al., 2024), while technology-integrated curriculum resources can increase student engagement and enhance academic achievement (Abubakar et al., 2024). A key framework in education technology research, the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) describes the complex knowledge needed by educators to work effectively with technologies in order to design and implement teaching and learning in ways that are suited to various content areas and diverse learner needs in a variety of settings and contexts through customized and/or differentiated instruction. Although prior research has characterized technology-integrated curriculum resources and examined the nature of technology use through the lens of pedagogical knowledge or descriptions of instructional practices that incorporate a single technology, much remains to be explored regarding how a range of curriculum-related dimensions might account for variance in students' academic outcomes.

This study goes beyond the teachers' integrated knowledge in TPACK and examined four dimensions of Technology-Integrated Curriculum (TIC), namely, the Balance of Curriculum, Technology, and Pedagogy; the Content Knowledge and Supports Meaningful Learning; the Enables Differentiated Instruction; and the Encourages Innovation. The direct predictive relationships between these four dimensions of TIC and the Academic Performance were examined in this study. Consequently, an integrated perspective on technology-supported learning and teaching was provided and context-specific empirical evidence from higher education institutions in Shandong Province, China was supplied.

The purpose of this study is to examine the relationships between four dimensions of Technology-Integrated Curriculum and Academic Performance among university students in Shandong Province, China. Specifically, the study investigates the individual predictive contributions of Balance of Curriculum, Technology, and Pedagogy; Content Knowledge and Supports Meaningful Learning; Enables Differentiated Instruction; and Encourages Innovation to students' Academic Performance.

Alternative Hypotheses

H1: Balance of Curriculum, Technology, and Pedagogy has a significant positive relationship with Academic Performance.

H2: Content Knowledge and Supports Meaningful Learning has a significant positive relationship with Academic Performance.

H3: Enables Differentiated Instruction has a significant positive relationship with Academic Performance.

H4: Encourages Innovation has a significant positive relationship with Academic Performance.

Literature Review

Technology-Integrated Curriculum (TIC) refers to the effective use of digital technologies to support teaching and learning within curriculum content and associated pedagogies. The term goes beyond mere presence of technology within teaching and learning and implies meaningful and integrated connection between technology, pedagogy and curriculum content (Mishra & Koehler, 2006). Such use of technology is to enhance teaching and learning within the curriculum and improves quality and effectiveness of education. Therefore, TIC

could be conceived as a multidimensional curriculum practice which can be studied within the framework of TPACK (Mishra & Koehler, 2006) namely, technological knowledge, pedagogical knowledge and content knowledge.

In the present study Technology-Integrated Curriculum is defined by four dimensions: Balance of Curriculum, Technology, and Pedagogy; Content Knowledge and Supports Meaningful Learning; Enables Differentiated Instruction; and Encourages Innovation. As different but complementary aspects of effective technology integration these four dimensions will be examined in greater detail within the present study, with reference to a body of evidence from China that includes, for example, positive effects on student learning from computer-assisted learning (Abbey et al., 2024), and also the relationships between technology-integrated curriculum resources and student engagement and academic achievement (Abubakar et al., 2024).

In terms of content, Technology-Integrated Curriculum for the 21st century focuses on several important elements: (1) Balance of Curriculum, Technology, and Pedagogy; (2) Content Knowledge and Supports Meaningful Learning; (3) Enables Differentiated Instruction; and (4) Encourages Innovation. Research has shown that appropriate use of digital technology can enhance learning and support students' meaningful engagement with curriculum. For example, evidence gathered from systematic reviews of evidence-based research on educational technology in China by Abbey et al. (2024) showed that computer-assisted learning had positive effects on student learning. The second element above, Content Knowledge and Supports Meaningful Learning, is supported by evidence in academic publications, which show how technology can be used to support students in achieving curriculum learning objectives and understanding a range of discipline-specific concepts and skills. The third element, Enables Differentiated Instruction, is important because all students learn differently and have different prior knowledge, skills, interests and learning styles. Goyibova et al. (2025) provided an excellent overview of Differentiation in Education, and how it can be facilitated by the use of technology to support a range of learning approaches and resources. The fourth element, above, Encourages Innovation, is increasingly important as emerging technologies such as AI become more integrated into higher education curricula. Southworth et al. (2023) explained the current higher-education landscape and explored emerging technologies for higher-education curricula innovation.

Academic Performance refers to students' learning results within specified education programs and contexts. In the higher education context supported by technology, the academic performance of students is influenced not only by their own characteristics and abilities but also by the academic program and the learning environment in which they study. When appropriate use is made of educational technology, the technology-supported learning environment has great potential to support and enhance academic performance. There is sufficient evidence to support that computer-assisted learning can improve student learning (Abbey et al., 2024). In addition, the relationship between technology-integrated curriculum resources and student engagement and academic achievement in higher education has been investigated (Abubakar et al., 2024). Thus, while technology use is prevalent in learning environments, using technology effectively for teaching and learning requires more than simply including more technology in teaching. The value of technology in learning environments is realized when technology supports teaching and learning of meaningful

curriculum and effective pedagogy and supports learning of different students through varied means of learning, and supports and encourages innovation. Thus, an examination of the dimensions of Technology-Integrated Curriculum can provide more comprehensive insights into the factors that affect Academic Performance of university students.

The incorporation of technology into higher education, there is a need to ensure that the curriculum is balanced between what is taught, how it is taught, and the technology used to support teaching and learning. Mishra and Koehler (2006) in their TPACK framework assert that when technological knowledge is integrated with pedagogical knowledge and content knowledge, technology becomes educationally meaningful. The evidence from research into the use of educational technology has shown that there is potential for improving student learning (Abbey et al., 2024). Thus, the greater the balance between curriculum, technology and pedagogy the greater the positive impact on students' Academic Performance. H1: Balance of Curriculum, Technology, and Pedagogy has a significant positive effect on Academic Performance.

Content Knowledge and Supports Meaningful Learning and Academic Performance. Technology should support the application of learning content for meaningful learning. It should facilitate students' exploration and application of the learning content and understanding of it. Digital technologies can support students' exploration of resources, ways of learning and multiple perspectives of meaning by means of which they can acquire deeper and more comprehensive understanding of the learning content. The evidence provided by Abbey et al. (2024) in their systematic review of the evidence concerning computer-assisted learning in China demonstrated that such learning has been found to improve student learning. The findings of Abubakar et al. (2024) also revealed that technology-integrated curriculum resources positively affect student engagement and academic achievement. H2: Content Knowledge and Supports Meaningful Learning have a significant positive effect on Academic Performance.

The TICTD dimension Enables Differentiated Instruction implies supporting all students in reaching their full potential by recognizing differences in prior knowledge, abilities, learning pace, interests, and educational needs. Differentiated instruction is described by Goyibova et al. (2025) as an approach to education that focuses on tailoring teaching and learning to meet the needs of individual students. A technology-integrated curriculum enables the provision of different forms of resources for students, which can facilitate access to learning for different types of learners. As a result, technology-supported instruction that is designed to reach different learning goals can positively affect Academic Performance of university students. H3: Enables Differentiated Instruction has a significant positive effect on Academic Performance.

Encourages Innovation and Academic Performance. By incorporating innovative learning resources into the curriculum, a technology-integrated curriculum can encourage students to explore new ideas, investigate emerging technologies, and to use technology to tackle problems. Higher education is currently undergoing a transformation through the integration of artificial intelligence into the curriculum (Southworth et al., 2023). Technology-integrated curricula therefore have the potential to deliver meaningful and innovative learning

experiences that can maximize student learning and help to achieve academic performance.

H4: Encourages Innovation has a significant positive effect on Academic Performance.

The study draws upon the theoretical framework of Technological Pedagogical Content Knowledge (TPCK) (Mishra & Koehler, 2006) and has been extended and modified to incorporate additional knowledge about supporting learning with technologies, enabling differentiated instruction and encouraging student and teacher innovation. In relation to the four research dimensions of the study therefore, the first dimension of Balance of Curriculum, Technology and Pedagogy draw upon the central principle of TPACK that Technology, Pedagogy and Subject Matter Content need to be fully integrated in order to support effective learning with technologies. The second dimension therefore, draws upon the interaction between the knowledge of Content and the knowledge of how to use Technologies and Pedagogies to support and support Meaningful Learning. The third dimension of the study Draws upon the knowledge of how to use Technologies, Pedagogies and Curriculum Content to support Differentiated Instruction. The fourth and final dimension of the study Draws upon the knowledge of how to use Technologies to support Innovation. Therefore, the four dimensions of Technology-Integrated Curriculum in this study can be explained using the TPACK framework in order to explain why Technology-Integrated Curriculum may have an impact upon Academic Performance. When Technology is fully integrated into teaching and learning with pedagogy and subject matter, then it is likely that students will experience a variety of ways in which they can learn in a coherent, meaningful, differentiated and innovative way that supports Academic Performance.

However, in terms of the research findings regarding the relationships between various elements of the Technology-Integrated Curriculum and Academic Performance, a number of gaps remain to be filled. With reference to the five references selected for this study, although individual dimensions of the Technology-Integrated Curriculum have been examined in terms of their relationship with Academic Performance, there is a serious lack of studies that investigate all four of the dimensions examined in this study as antecedents of Academic Performance. In terms of empirical studies conducted within higher education, there is also a particular lack of research that has focused upon university students in Shandong, China. Thus, whilst a considerable body of empirical research has been conducted concerning a range of aspects of Technology-Integrated Curriculum, for example, the TPACK of teachers (Mishra & Koehler, 2006), the application of differentiation within Technology-Integrated Curriculum (Goyibova et al., 2025), and the application of emerging technologies within higher education curricula (Southworth et al., 2023), a number of serious gaps remain in terms of research concerning the four dimensions of the Technology-Integrated Curriculum examined in this study in relation to Academic Performance. The present study seeks to address these particular research gaps by means of an empirical study in which all four of the dimensions of the Technology-Integrated Curriculum examined in this study are used as predictors of Academic Performance among university students in Shandong, China.

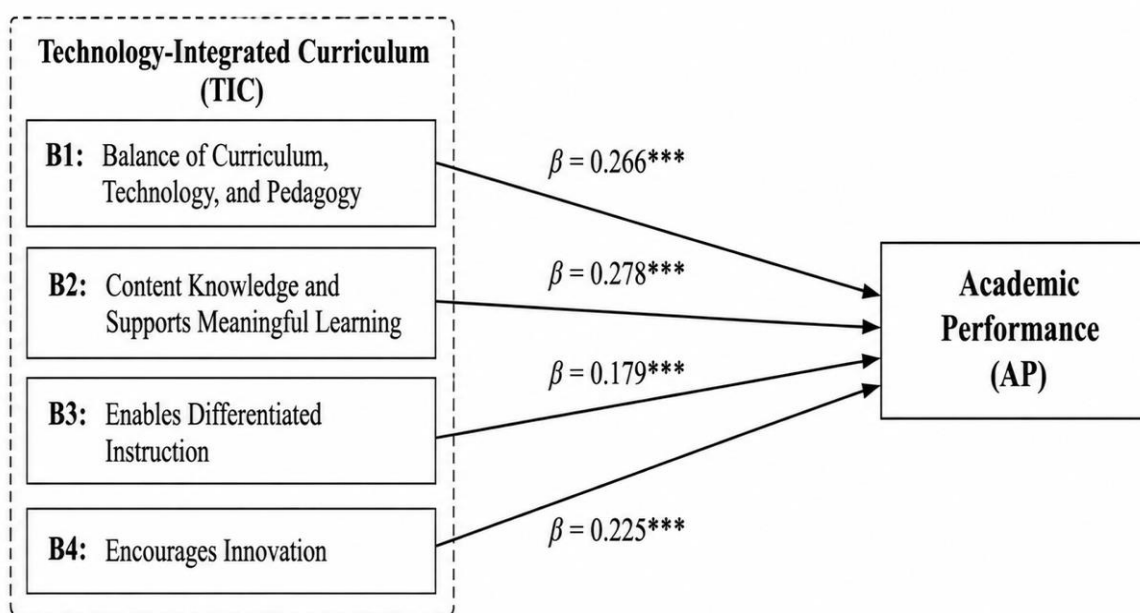
Methodology

The study adopts a quantitative correlational research design to investigate the effect of technology-integrated curriculum on four dimensions of university education, namely, Balance of Curriculum, Technology, and Pedagogy; Content Knowledge and Supports Meaningful Learning; Enables Differentiated Instruction; and Encourages Innovation and

Student Engagement. The quantitative study aims to examine the relationships between the four technology-integrated curriculum dimensions and Student Engagement through the lens of higher education students in Shandong, China. In total, 388 higher education students completed a survey using a structured questionnaire that consisted of four parts of technology-integrated curriculum and one part of Student Engagement. The study employs descriptive and inferential statistics. Frequencies and percentages were used to describe the characteristics of the respondents and the study variables. The means and standard deviations were also calculated to further examine the study variables.

Findings and Discussion

This section presents results from the four dimensions of Technology-Integrated Curriculum investigated in this study. Results from test of the study's hypotheses are presented, compared with those of previous related studies, and discussed in relation to the theoretical framework of the study.



Note. β = standardized path coefficient. *** $p < .001$.

Figure 1 Effects of Technology-Integrated Curriculum Dimensions on Academic Performance

Figure 1 presents four Technology-Integrated Curriculum dimensions and their respective effects on Academic Performance. Results showed that all four dimensions of Technology-Integrated Curriculum positively and significantly affected the students' Academic Performance ($p < .001$). The strongest effect was from Content Knowledge and Supports Meaningful Learning followed by Balance of Curriculum, Technology, and Pedagogy, then Encourages Innovation, and lastly Enables Differentiated Instruction. Thus, all four Technology-Integrated Curriculum dimensions are effective in enhancing students' Academic Performance.

Table 1

Hypothesis Testing

Hypothesis	Relationship	Original Sample (β)	Sample Mean	Standard Deviation	T Statistics	P Values	Decision
H1	Balance of Curriculum, Technology, and Pedagogy → Academic Performance	0.266	0.267	0.031	8.465	< 0.001	Supported
H2	Content Knowledge and Supports Meaningful Learning → Academic Performance	0.278	0.280	0.033	8.330	< 0.001	Supported
H3	Enables Differentiated Instruction → Academic Performance	0.179	0.181	0.036	5.042	< 0.001	Supported
H4	Encourages Innovation → Academic Performance	0.225	0.226	0.033	6.760	< 0.001	Supported

Table 1 presents results for testing hypotheses for effects of four dimensions of Technology-Integrated Curriculum on Academic Performance. All four dimensions had significant positive effects. All four hypotheses were supported. The effects were largest for Content Knowledge and Supports Meaningful Learning ($\beta = .278$), followed by Balance of Curriculum, Technology, and Pedagogy ($\beta = .266$), Encourages Innovation ($\beta = .225$), and Enables Differentiated Instruction ($\beta = .179$).

H1: Balance of Curriculum, Technology, and Pedagogy → Academic Performance

H1 showed a significant positive effect on Academic Performance ($\beta = .266$, $p < .001$). Therefore, there is evidence that students do better academically when there is an appropriate balance of the curriculum, technology and pedagogy. This is in line with the work of Mishra and Koehler (2006) who proposed the TPACK framework for effective use of technology in teaching. This framework reveals that effective use of technology for teaching and learning depends on the combination of technological, pedagogical and content knowledge. The findings of the present study were also similar to those of Abbey et al. (2024) who conducted a study to explore the impact of educational technology on student learning in China. In that study, findings revealed that appropriate use of technology for teaching and learning led to enhanced learning outcomes among students. It is evident that technology has a greater impact on academic performance when used to enhance the existing curriculum and pedagogy rather than to replace them. H1: Accepted – Balance of Curriculum, Technology, and Pedagogy has a significant positive effect on Student Engagement.

H2: Content Knowledge and Supports Meaningful Learning → Academic Performance

H2 also showed a significant positive effect on Academic Performance ($\beta = .278$, $p < .001$), representing the strongest effect. This correlation was the strongest among the four Technology-Integrated Curriculum dimensions. Therefore, result showed that using technology to enhance students' understanding of the curriculum and to make learning meaningful is very important. This finding is also in line with that of Mishra & Koehler (2006) in which they stated that technological applications are connected to appropriate content and pedagogical knowledge, known as TPACK. In this study we also found that there was a positive correlation between using technology-integrated curriculum resources and students' academic achievement (Abubakar et al., 2024). Therefore, the use of technology for learning is most beneficial when it is used to support students' learning of curriculum content and how to apply what they learn. H2: Accepted – Content Knowledge and Supports Meaningful Learning have a significant positive effect on Student Engagement.

H3: Enables Differentiated Instruction → Academic Performance

H3 had a significant positive effect on Academic Performance ($\beta = .179$, $p < .001$). The path coefficient for this dimension is the smallest of the four, yet is still significant. Therefore, technology-supported differentiation also supports Academic Performance. Elaborated technology-supported differentiation enables students to have learning opportunities that are tailored to their ability, readiness, and learning pace as well as to their educational needs. Goyibova et al. (2025) identified that differentiated instruction refers to approaches that support learning for diverse groups of students by facilitating tailoring of instruction to individual student differences and learning needs. Within the framework of TPACK, however, Enables Differentiated Instruction using technology means that lecturers use technology to select and to use particular and pedagogically-appropriate educational content in order to support specific subjects' learning by diverse learners. In summary, this dimension offers an additional way in which Curriculum Integration leads to improved Academic Performance. H3: Accepted – Enables Differentiated Instruction has a significant positive effect on Student Engagement.

H4: Encourages Innovation → Academic Performance

H4 also demonstrated a significant positive effect on Academic Performance ($\beta = .225$, $p < .001$). The effect indicates that the curricula using technology to enable innovative ways of learning, to support experiments, problem solving and other creative approaches to academic content also enable high academic achievement. This effect is also found by Southworth et al. (2023) in their review of emerging technologies, including AI, for higher education, and is in line with the finding from the TPACK perspective (Mishra & Koehler, 2006) that innovation occurs when technology, content and pedagogy are combined for meaningful learning rather than technology being introduced as a separate entity. This therefore supports the importance of curriculum innovation as part of the technology integration to improve Academic Performance of university students. H4: Accepted – Encourages Innovation has a significant positive effect on Student Engagement.

Conclusion

The four dimensions of Technology-Integrated Curriculum, in alternative hypotheses, all had positive effects on Academic Performance of university students in Shandong, China. The first dimension, Content Knowledge and Supports Meaningful Learning, contributed the largest effect to Academic Performance, followed by the second dimension, Balance of Curriculum,

Technology, and Pedagogy, Encourages Innovation, and the third dimension, Enables Differentiated Instruction. This means that all four alternative hypotheses were supported and that Technology-Integrated Curriculum, in order to enhance academic outcomes of students, has to be aligned meaningfully with technology, curriculum content, pedagogy, differentiated learning, and innovation.

From a theoretical perspective, the results support the TPACK framework, which posits that meaningful technology use is ultimately connected to improved learning outcomes by combining technology, pedagogy, and content in the classroom. Practically speaking, findings from the current study suggest that university technology supports should focus on technologies that support strong content knowledge, meaningful learning, and other meaningful dimensions of Technology-Integrated Curriculum when implemented in combination with appropriate teaching approaches and curriculum objectives. Teachers also need to incorporate technology into their teaching practices to provide support for students' needs and facilitate innovative learning approaches.

However, the present study is confined to the students of universities in Shandong, China. Further research is required to generalize the findings to the students of other parts of the globe. The present study adopted cross-sectional design. The data were collected through self-report questionnaires. Therefore, the causal relationship between variables cannot be confirmed and there is possibility of response bias. In the present study, only four dimensions of Technology-Integrated Curriculum have been investigated. The findings of the present study could be influenced by other technological, institutional, teacher-related and student-related factors.

Future studies should be conducted in other universities in different provinces and countries. Longitudinal research or even experiments could provide stronger evidence for the effects of Technology-Integrated Curriculum on Academic Performance. Furthermore, additional variables such as students' engagement, digital literacy, learning motivation, teachers' pedagogical competence, and access to technology could be investigated as potential mediators, moderators, or additional predictors of Academic Performance.

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