From Digital Competence to Professional Competence: Mediating Roles of Attitude and Engagement with E-Sports Insights

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Abstract **- In the era of digital transformation, digital competence has become a critical driver in shaping university students' professional capabilities. This study adopted a mixed-methods design, with Phase 1 comprising a survey of 150 university students, and Phase 2 involving semi-structured interviews with 30 participants from the same cohort to further explore and contextualize the quantitative findings. A structural equation model was constructed to examine the sequential mediating roles of learning attitude and learning engagement in the relationship between digital competence and professional competence. The analysis, supported by bootstrap mediation testing and word frequency patterns from interview data, revealed that digital competence indirectly promotes professional competence through this dual pathway. It was found that learning attitude emerged as a key driver of engagement highlighting the role of emotional and motivational factors in shaping students' professional competence development. Insights from the qualitative phase further suggest that while e-sports may enhance certain competencies such as strategic thinking and collaboration, excessive engagement in such activities can interfere with academic priorities.**

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1. Introduction

The university education and vocational training are designed to equip individuals with essential competencies for both employment and self-employment. In fact, in today's evolving digital economy, the demand for a diverse and dynamic set of skills has challenged the shift in curriculum design to meet the needs of the contemporary workforce [1], [2]. It is key for university programs to align with digital economy. Reflecting this urgency, the European Commission [3] has called for a systemic reform in digital education.

The Fourth Industrial Revolution is already underway and its impact across various industries including the field of education is profound. The advancement of the digital technologies has transformed the nature of information literacy instruction. The emerging education trend has thus become a strategic priority in higher education aimed at equipping students with skills to effectively utilize digital information in academic as well as professional environment [4]. Given the transformative impact of digital technology on educational paradigms and professional competency (PC) demands, digital competence (DC) has become a key determinant for individual professional growth and career advancement. Largely, individuals with a high level of DC possess greater competitiveness in the digital society.

Each year, universities produce a large number of graduates, including those in electronic information technology fields. However, many of these graduates lack sufficient PC contributing to employment difficulties and industry-university skill mismatches.

Furthermore, [5] observed that the underutilized labour and low productivity threaten China's competitiveness in global innovation industries and commented that *"the technology sector in China has experienced rapid growth, yet there is often a horizontal mismatch where graduates in non-technical fields, such as business or liberal arts, are employed in tech companies in roles that require soft skills, like project management or sales, rather than technical skills like coding or engineering. While these graduates are employed, they are not fully utilizing their academic backgrounds, and the industry still faces shortages in technical expertise"* [5]. Survey also showed that over 90% of professional job require a solid level of digital proficiency but many still lack sufficient skills including about 37% of the European workforce are without basic digital skills [6].

Recent advancements in digital pedagogy highlight the role of digital literacy as a meta-competency that amplifies both self-regulated learning and industry-specific skill acquisition. High level of DC enables learners to navigate and manage digital environments effectively thus fostering autonomous learning behaviors such as goal setting, time management, and critical reflection [7].

Prior studies have predominantly focused on isolated factors such as technical skills or cognitive engagement [8], disregarding the relationship between affective-motivational dimensions such as learning attitudes (LA) and learning engagement (LE) which are often known as behavioral investment. Investigating these combined effects is crucial as DC, LA, and LE are sequentially linked and mutually reinforcing collectively shaping students' cognitive, behavioral, and emotional investment in learning and ultimately contributing to the development of PC. Despite the growing significance of DC, empirical evidence of its impact on domain-specific professional competencies particularly within vocational disciplines remains fragmented.

In recent years, researchers have dedicated more attention on gamified learning as it is widely recognized as an innovative pedagogical approach with a potential to promote knowledge retention [9], [10], and foster career readiness and skill development relevant to higher education and employment pathways [11]. E-sports games combining with spectator and competitive game, enhancing user participation and interactivity. Schools that adopted e-sports have witnessed greater participation of students in school activities. This new way of life in society not only promotes cultural exchange and understanding on a global scale, it has also become a mainstream entertainment form for many young people worldwide [11].

Study by [12] supported the idea that esports-based learning can translate into transferable professional competencies especially in teamwork and social skills. However, excessive immersion in recreational digital activities, including unregulated or prolonged esports participation, may paradoxically erode academic focus and cognitive self-discipline.

Contemporary educational psychology recognizes that cognitive, emotional, and behavioral factors are deeply interconnected in the development of essential skills [13], [14]. In the context of developing PC, it is important to understand the chain relationship among LA, LE and DC rather than viewing these constructs in isolation. Thus, this study addresses the following two research questions.

RQ 1: How does DC influence PC among students through the mediating roles of LA and LE?

RQ 2: Do emerging digital practices, such as e-sports, influence the development process of PC?

By developing a sequential mediation model that incorporates LA and LE, this study aims to unravel the "black box" of capability transformation in learners by providing a deeper understanding of how DC contributes to the development of PC among university students (Figure 1).

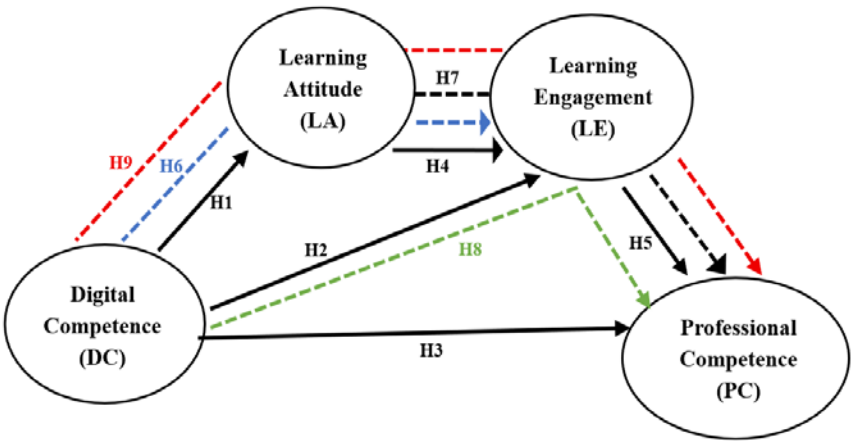


Figure 1. A chain mediation model of professional development

2. Literature Review and Hypotheses Framing

To provide a foundation for this study, the following section reviews relevant theoretical and empirical work on DC, LA, LE and PC. These insights form the basis for developing the research hypotheses.

DC has emerged as a critical factor influencing students' learning behaviors and academic success for higher education. According to the European Digital Competence Framework for Citizens (DigComp 2.2), digital competence includes not only technical skills but also cognitive, social, and affective abilities related to information literacy, communication, content creation, safety, and problem-solving [15]. It emphasizes using digital tools responsibly and effectively for learning, participation, and personal growth.

This concept of DC has evolved beyond a technical construct and is now widely regarded as a multidimensional enabler of students' psychological and behavioral engagement in digital learning environments. It fosters learners' self-efficacy, academic motivation, and confidence which in turn enhance their cognitive investment, emotional involvement, and active participation. Rather than merely equipping students with operational skills, DC supports self-regulated learning, reflective thinking, and collaborative practices, allowing students to engage meaningfully with digital content and their peers. As such, students with higher DC are more likely to demonstrate sustained motivation and adaptive behaviors necessary for success in technology-rich academic settings [16], [17], [18], [19].

2.1. Digital Competence to Learning Attitude (DC → LA)

A positive relationship between DC with LA has been well established. Students with higher DC levels tend to develop more favorable attitudes toward digital learning characterized by increased motivation, confidence, and openness to using technology [20]. When students feel confident in their digital skills, they are more likely to view technology as useful and approachable, which enhances their motivation and openness to learning [21]. Thus, the following hypothesis is proposed:

H1: DL positively influences LA.

2.2. Digital Competence to Learning Engagement (DC → LE)

Work by [17] found that digitally competent students were more engaged across various aspects of engagement particularly due to heightened self-efficacy and autonomy in digital environments.

Similarly, [18] noted that digital skills promote active learning through elaboration, reflection, and interaction. This reflects DigComp's emphasis on higher-order skills such as problem-solving, critical thinking, and collaboration, which are foundational to sustained engagement in technology-enhanced learning [15]. Thus, the following hypothesis is proposed:

H2: DL positively influences LE.

2.3. Digital Competence to Professional Competence (DC → PC)

DC fosters advanced information processing, critical thinking, and self-directed learning capabilities, which in turn enhance professional competence which is known as a fundamental component of career readiness. By integrating digital skills within applied pedagogies such as problem-based learning and agile teamwork, it enhances students' practical learning outcomes and strengthens their professional competencies including communication, teamwork, and strategic thinking [22]. Similarly, it was found that digital platforms which support autonomy and interaction can increase students' confidence in their learning capacities [23]. These findings suggest that DC fosters the development of PC by enabling students to navigate digital tasks effectively, collaborate meaningfully and apply their skills in real working world. Thus, the following hypothesis is proposed:

H3: DL positively influences PC.

2.4. Learning Attitude to Learning Engagement (LA→ LE)

Positive learning attitude has also been shown to significantly influence greater learning engagement. Students who view digital technologies as useful and accessible are more likely to participate actively and meaningfully in academic tasks [20]. When students perceive learning as meaningful and enjoyable, they are more likely to demonstrate behavioral persistence, emotional involvement, and cognitive investment in learning activities. Particularly in digitally enriched classrooms, the learners with favorable attitudes toward technology-enhanced learning are more willing to explore content, interact with peers, and self-regulate their progress [18], [22].

Thus, the following hypothesis is proposed:

H4: LA positively influences LE.

2.5. Learning Engagement to Professional Competence (LE→ PC)

LE is a critical driver of professional competence development particularly among university students because they are expected to acquire not only academic knowledge but also workplace-relevant skills. Previous studies [23], [24] demonstrated that engagement mediates the relationship between professional identity and career adaptability indicating that students who are more engaged in learning are better prepared to navigate future professional challenges. In fact, engaged learners such as students who actively participate, think critically, and persist in challenging tasks are more likely to develop competencies aligned with professional expectations [9], [22]. Thus, the following hypothesis is proposed:

H5: LE positively influences PC.

2.6. Mediating Roles of Learning Attitude and Learning Engagement

In the evolving digital learning landscape, DC has become as a multidimensional enabler of learning and PC development. It encompasses not only technical capabilities but also reflective attitudes, adaptive dispositions, and the capacity to navigate digital environments meaningfully [25]. This suggests that learners with strong DC are more likely to develop positive LA and subsequently influence how the learners approach tasks, process information, and sustain LE.

Previous studies [2], [26] have confirmed the transformative role of DC in shaping the psychological and behavioral dimensions of professional development. DC particularly in the form of digital motivation, awareness, and confidence predicts educators' willingness to adopt innovative teaching practices and engage in continuous learning [26]. Meanwhile, [2] argued that the learners' initiative, engagement, and adaptability are key to PC development.

Previous researchers [23] highlighted the role of digital learning platforms in promoting students' autonomy, interaction, and immediate feedback to enhance students' confidence in their learning abilities as well as their capacity to apply acquired knowledge in professional settings. These platforms not only increase LE but also nurture transferable skills such as decision-making, self-direction, and collaboration which important to the development of PC in the digital workplace.

Together, these findings support a dual and chained mediation model, whereby digital competence enhances professional competence through both direct behavioral engagement (DC → LE → PC) and a sequential cognitive-affective pathway (DC → LA → LE → PC).

This layered mechanism reflects how digital readiness supports the development of professional growth by shaping learners' attitudes and encouraging active engagement. Thus, the following hypotheses are proposed:

H6: LA mediates the DC-LE relationship.

H7: LE mediates the LA-PC relationship.

H8: LE mediates the DC-PC relationship.

H9: LA and LE mediate the DC-PC relationship.

3. Methodology

This study employed a mixed-methods approach comprising a quantitative survey followed by qualitative interviews to address the research questions.

In Phase 1, a structural equation model (SEM) was constructed based on literature review to examine hypothesized relationships among latent variables. Measurement items in this study were adapted from peer-reviewed CSSCI journal literature published within the last five years. The final survey instrument included 21 items covering four key constructs: digital competence (DC), learning attitude (LA), learning engagement (LE), and professional competence (PC). Following [27]'s scale development paradigm, the questionnaire items were refined through a double-blind back-to-back translation process to ensure content validity.

Specifically, six items assessing DC were adapted from the DIGCOMP 2.1 framework, focusing on students' ability to use digital tools such as social media for learning and professional development. Three items measuring LA were adopted from the National Survey of Student Engagement-China capturing the students' motivational orientation and confidence in learning. Seven items assessing LE were adapted from the Utrecht Work Engagement Scale [28].

It reflects the students' cognitive, emotional, and behavioral involvement in the learning process. Finally, five items measuring PC were self-developed based on a review of relevant literature. All constructs were measured using a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Data were collected through an online questionnaire survey administered by the researchers. A total of 150 second-, third- and fourth-year students from a university in Guangzhou, China participated in the study. Participants ranged in age from 18 to 23 years (M=20.4, SD=1.27) with a balanced gender ratio (1:1). All participants provided informed consent and received a 20 yuan token of appreciation for their time.

In Phase 2, semi-structured interviews were conducted with 30 students selected via purposive sampling from the survey pool, also with a balanced gender ratio (1:1). The interview protocol was developed in alignment with the constructs of the study and focused on participants' perception of how emerging digital practice i.e., e-sports impact their learning processes and PC development. These participants were encouraged to express their views freely, with interviews averaging 12 minutes in length. To ensure objectivity and minimize researcher bias, the interviews were conducted using open-ended, non-leading questions [29]. Both the questionnaire survey and interview protocol received ethical approval from the university's research ethics committee prior to data collection.

4. Data Analysis and Results

In this study, data analysis was conducted in two phases to address the research questions. The first phase employed a quantitative approach using structural equation modeling (SEM) to examine the relationships among digital competence (DC), learning attitude (LA), learning engagement (LE), and perceived competence (PC). The second phase adopted a qualitative approach, utilizing semantic network analysis to explore the role of e-sports in the development of PC.

4.1. Phase 1: Data Cleaning and Preparation

The 150 collected questionnaires underwent a rigorous data cleaning process to ensure the quality and reliability of the dataset. First, five responses were excluded due to incomplete data resulting in 145 valid responses. Second, a validation was performed on the remaining data confirming the absence of multicollinearity and extreme outliers. The variance inflation factor (VIF = 1.28) indicated no multicollinearity issues whereas the Mahalanobis distance test yielded non-significant results ($p > 0.001$), supporting the assumption of multivariate normality. The quantitative analysis was carried out with the final sample of 145 responses.

4.2. Phase 1: Quantitative Findings

This section presents the results of the structural equation modeling (SEM) analysis conducted to examine the hypothesized relationships among DC, LA, LE and PC. The analysis includes assessment of measurement reliability and validity followed by evaluation of the structural model. The hypotheses were tested through the analysis of path coefficients using the structural model.

Initial model fit indices ($\chi^2/df = 2.398$, Comparative Fit Index [CFI] = 0.893, Root Mean Square Error of Approximation [RMSEA] = 0.099) did not reach the conventional thresholds [30]. To optimize parsimony, DC2 item was removed based on modification indices (MI > 10), resulting in improved fit ($\chi^2/df = 2.378$, CFI = 0.90, RMSEA = 0.098). This aligns with iterative model refinement in SEM for balancing complexity and explanatory power [31]. The following presents the results of the hypothesis testing.

Based on the structural model results, 7 out of 9 hypotheses were supported except for H2 and H8 (Table 1). A bootstrap resampling with 5,000 iterations procedure was employed to assess the mediation pathways [32]. In terms of the direct effects, DC had a significant positive impact on LA ($\beta = 0.298$, $p = 0.019$), confirming H1. However, it was found that DC primarily influences PC through the sequential attitude-engagement pathway (62% total effect) with no significant direct effect from DC to PC. The H2 is not supported. DC also showed a significant direct effect on PC ($\beta = 0.253$, $p = 0.003$), supporting H3. Furthermore, LA had a strong positive influence on LE ($\beta = 0.819$, $p < 0.001$), supporting H4 whereas LE significantly impacted PC ($\beta = 0.718$, $p < 0.001$), confirming H5. For the sequential mediation pathway, the indirect effect of digital competence through learning attitude and learning engagement on profession competence: DC → LA → LE → PC was also significant ($\beta = 0.175$, 95% CI [0.102, 0.258]), confirming H9. Decomposition of effects revealed that 42.3% of the total effect of DC on PC was direct whereas 57.7% was mediated highlighting the crucial role of LA and LE in the capability transformation process.

Table 1. Results of hypotheses testing

	Path	β	S.E.	C.R.	p	Outcome
H1	DC → LA	0.298	0.127	2.347	0.019	Supported
H2	DC → LE	-0.045	0.090	-0.507	0.612	Rejected
H3	DC → PC	0.253	0.084	3.003	0.003	Supported
H4	LA → LE	0.819	0.094	8.702	<0.001	Supported
H5	LE → PC	0.718	0.088	8.151	<0.001	Supported
	Path	**β**	**S.E.**	**C.R.**	**95% CI**	**Outcome**
H6	DC → LA → LE	0.244	---	---	[0.134, 0.367]	Supported
H7	LA → LE → PC	0.588	---	---	[0.412, 0.751]	Supported
H8	DC → LE → PC	0.123	---	---	[–0.096, 0.041]	Rejected
H9	DC → LA → LE → PC (Sequential)	0.175	---	---	[0.102, 0.258]	Supported

Findings in this study align with previous study [14] where the role of attitudinal transformation and behavioral investment is key in fostering competence. This study proposes a more structured pathway in which DC sequentially shapes LA, which in turn drives LE culminating in perceived capability. The strong effect of LA on LE (β = 0.819) highlights the importance of emotional education in sustaining active learning. For instance, blended learning pedagogies that incorporate motivational scaffolding can enhance students' self-efficacy and emotional readiness to engage which is consistent with the foundational work of Bandura [30] and more recent findings by [33].

Using user-defined estimands for chain multiple mediation analysis in AMOS, the results show that the indirect effects for H6, H7, and H9 are 0.244, 0.588, and 0.175, respectively. The findings indicate that LA plays a key role in connecting DC to LE (H6 is supported). In addition, LE significantly mediates the relationship between LA and PC (H7 is supported). Together, LA and LE form a significant chain mediating effect between DC and PC (H9 is supported). However, since the data does not support the H2, H8 is also considered unsupported.

4.3. Phase 2: Analysing Interview Data

To analyze the interview data, this study adopts a semantic network analysis approach supported by keyword co-occurrence matrices and TF-IDF weighting to assess the students' affective responses toward e-sports and its perceived impact on professional competence. While sentiment analysis techniques were referenced [34], the present section emphasizes cognitive and behavioral constructs (e.g., PC, pressure) over affective classification. To derive meaningful insights from the interview transcripts, a three-step natural language processing (NLP) procedure was employed:

Step 1: Data Preparation - The interview texts were cleaned and preprocessed using the Word Cloud Platform [35]. This step involved the identification of key compound terms e.g., "gamified learning" and the consolidation of semantically similar expressions. For instance, terms such as "e-sports," "online sports," and "electronic games" were unified to maintain consistency across the dataset. The use of a customized lexicon and synonym merging helped ensure that the keywords used in subsequent analysis were both contextually accurate and analytically coherent [36].

Step 2: Topic Modeling - The Hidden Dirichlet Distribution (LDA) algorithm was applied to automatically classify the interview content into coherent thematic categories [34]. Following the automated clustering, manual review and refinement of topic labels were conducted to improve interpretability. For example, within the broader theme of e-sports, preliminary subcategories such as "entertainment" and "strategy" were merged into conceptually richer categories like "professional competence" and "pressure".

Step 3: Sentiment Analysis - To examine the participants' affective orientations, sentiment scores were calculated by matching TF-IDF–weighted keywords against a pre-defined sentiment lexicon as applied in e-sports context. Next section presents the findings from interview data. Each keyword was assigned a sentiment value ranging from -40 to +40 capturing its emotional polarity and intensity. These values were visualized through scatter plots enabling the exploration of emotional variance within and across thematic categories. This method not only quantified attitudinal trends but also revealed ambivalent perceptions such as the simultaneous framing of e-sports as both a tool for "ability enhancement" and a source of "time spent."

4.4. Phase 2: Qualitative Findings

Drawing on 30 interviews - these qualitative data were examined to understand the role of e-sports in shaping the participants' professional competence.

First, this section presents the major themes that emerged, followed by the identification of key thematic patterns related to e-sports. Based on the word-frequency analysis, ten most prominent keywords derived from the interview data were highlighted and visualized through a thematic word network. Second, the thematic mapping of e-sports was provided to illustrate the structural relationships among themes. Third, the participants' emotional tendencies toward e-sports were presented to offer additional insight into their perceptions and experiences.

4.4.1. Theme Distribution for E-Sports

The qualitative findings reveal a nuanced understanding of participants' perceptions toward e-sports highlighting both its developmental potential and associated challenges. This is reflected in the difference in the proportion of high-frequency themes "Professional Competence" (36.67%) and "Pressure" (23.33%) across the 30 interview records as in Table 2.

Table 2. Proportion of theme names in e-sports

Number of theme names	Number of records	Number of theme words	Co-occurrence frequency
Professional Competence	11 (36.67%)	13	8 (61.54%)
Pressure	7 (23.33%)	14	13 (92.86%)
E-sports	6 (20.00%)	16	16 (100.00%)
Time Spent	4 (13.33%)	17	17 (100.00%)
Total	28 （93.33%）		

As illustrated in Table 2, the four major themes collectively represent 93.33% of the dataset shows that the classification framework effectively captures the central issues. A closer examination of keyword frequency reveals that while "time spent" recorded the highest number of keywords (17), it had the lowest thematic proportion (13.33%). This implies that time management concerns were frequently mentioned but often discussed at a superficial level, typically framed as "occupying time" or "difficult allocation," without offering concrete solutions. While the benefits to PC through e-sports may be undermined by concerns over time spent and related stress, a participant in the interview said: "*When we engage in cooperative gameplay in e-sports games, it can improve our communication, coordination, and cooperation skills; however, when we become addicted, we may lose interest in studying and reduce our study time*."

Similar pattern is also reflected in Figure 2 where the theme of "time spent" has the smallest area, but there is some overlap with other themes such as "pressure" suggesting that time management issues may be a potential cause of academic pressure.

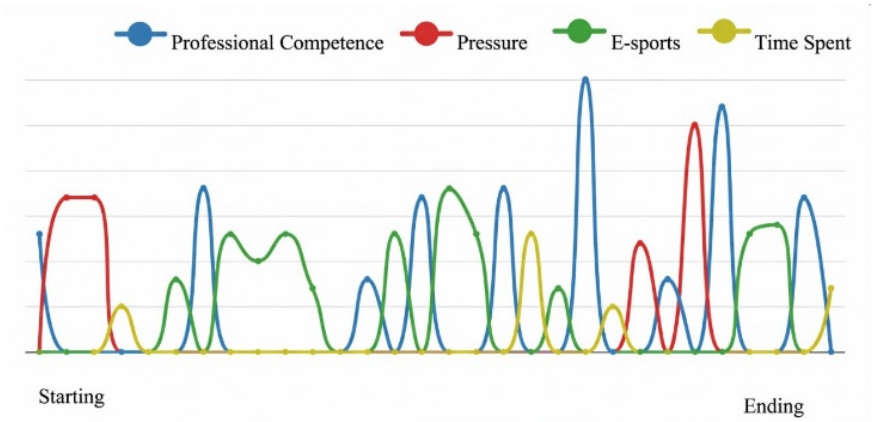


Figure 2. Thematic pattern in e-sports

Table 3 indicates that e-sports ranks highest in word frequency (50 occurrences) and has a TF-IDF value of 0.01 significantly higher than that of 'academic' (0.007). This suggests that the term is both frequently mentioned and contextually distinctive.

As one of the participants noted, "*In the process of participating in electronic games, strategies and techniques are needed; mastering the requirements of electronic games can help improve professional skills*".

Table 3. Top 10 keywords in e-sports

Word	Word Frequency	Number of Items	TF-IDF
E-sports	50	21	0.010
Impact	24	16	0.009
Time Spent	21	12	0.012
Ability	12	8	0.010
Academic	10	10	0.007
Pressure	9	6	0.009
Cooperation	8	6	0.008
Teamwork	7	5	0.007
Professional Competence	5	4	0.006
Individuals	5	4	0.006

Further analysis of the theme relationship matrix reveals multidimensional associations between 'e-sports' and related terms such as "impact" (52 co-occurrences), "time spent" (26), "ability" (23), "academic performance" (22), "teamwork" (15), "cooperation" (13), "professional competence" (10), and "pressure" (10), indicating the broad and interconnected influence of e-sports as in Table 4.

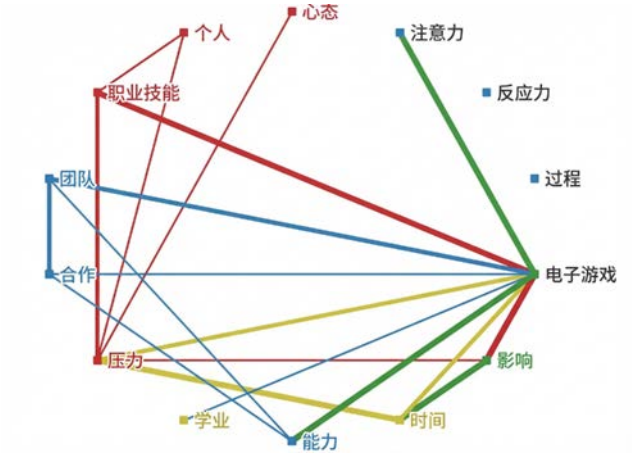
Table 4. Keyword co-occurrence matrix in e-sports

Word	SE	Imp	Time	Abi	Aca	Pre	Co	Team	PC	Ind
ES	50	52	26	23	22	10	13	15	10	9
Imp	52	24	19	2	9	9	5	4	7	9
Time	26	19	21	5	14	13	6	5	0	2
Abi	23	2	5	12	2	0	11	10	1	1
Aca	22	9	14	2	10	4	3	4	0	1
Pre	10	9	13	0	4	9	0	0	5	5
Co	13	5	6	11	3	0	8	10	0	0
Team	15	4	5	10	4	0	10	7	0	0
PC	10	7	0	1	0	5	0	0	5	5
Ind	9	9	2	1	1	5	0	0	5	5

Note: ES= E-sports, Imp= Impact, Time= Time Spent, Abi= Ability, Aca= Academic, P= Pressure, Co= Cooperation, Team= Teamwork, PC= Professional Competence, Ind= Individuals

In terms of positive relationship, e-sports has strong associations with "abilities" (23), "teamwork" (15), and "cooperation" (13) highlighting their role in fostering PC through simulated real-life challenges. Meanwhile for negative relationship, e-sports has moderate associations with "time" (26) and "pressure" (10) suggest a contradictory impact.

As shown in Figure 3, the results of thematic word network of e-sports reveal several triangular relationships such as *e-sports−impact−time spent*, *e-sports−ability−team*, *e-sports−impact−PC*, and *e-sports − time spent − pressure*. The triangular relationships of *ability − cooperation − team* and *pressure−PC−individual* show specific mechanisms for enhancing PC simulating real-world team-based scenarios that enhance strategic thinking and cooperative skills.



Note: E-sports (电子游戏), Impact (影响), Time Spent (时间), Ability (能力), Academic (学业), Pressure (压力), Cooperation (合作), Teamwork (团队), Professional Competence (职业技能), Individuals (个人)

Figure 3. Thematic word network in e-sports

An important finding from the interview data reveals that the *e-sports − time spent − pressure* relationship reflects participants' view that academic strain arises more from poor time management than from gaming itself. These findings indicate a need for further investigation into how factors such as time, cognitive abilities, collaboration, and teamwork mediate the relationship between digital engagement and PC development.

4.4.2. Theme Mapping for E-Sports

Based on TF-IDF–weighted word frequencies and sentiment lexicon matching, sentiment scores were assigned to key topic words, ranging from -40 to +40, and visualized through scatter plots (Figure 4).

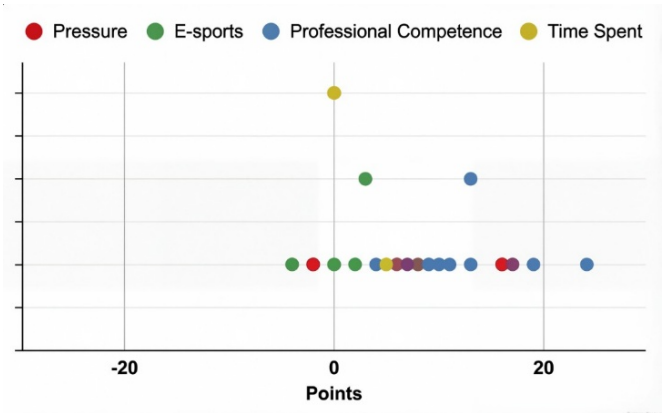


Figure 4. Thematic word network in e-sports

It was found that the lowest sentiment score is -4 associated with "video games", while the highest is 17 linked to both "pressure" and "professional competence". The average sentiment scores for key terms are as follows: pressure (8 points), e-sports (1 point), professional competence (10.3 points), and time spent (1.25 points).

Notably, the average score across all keywords exceeds 1 point, with "professional competence" exhibiting the highest average sentiment score (10.3), reflecting a generally positive perception of its relevance.

4.4.3. Emotional Tendencies toward E-Sports

An analysis of TF-IDF weighted word frequencies reveals a clear emotional tendency in how students perceive e-sports. Positive terms such as "improve" (TF-IDF 0.006), "ability" (TF-IDF 0.004), and "focus" (TF-IDF 0.003) appear frequently as in Table 5. This indicates that participants largely recognize the potential of e-sports to enhance specific cognitive and personal development.

Table 5. Positive emotion keywords related to e-sports

Word	Word Frequency	Number of Items	TF-IDF
Learning	29	19	0.004
Able	22	13	0.006
Improve	17	10	0.006
Abilities	7	5	0.004
Relieve	6	5	0.003
Focus	6	6	0.003
Require	5	5	0.003
Exercise	5	4	0.003
Certain	5	4	0.003
Understanding	5	5	0.003

However, sentiment scores associated with "e-sports" reflect a polarised distribution ranging from -4 to +4 points as displayed in Figure 4. This ambivalence suggests that while participants acknowledge the benefits of e-sports, concerns also exist particularly regarding time misuse and addiction risks. The average sentiment score of 1 for "e-sports" supports this neutral-to-leaning-positive perspective.

The sentiment values for different themes cluster differently. The related words for "Professional competence" (blue dots) exhibit strong positive sentiment while "pressure" (red dots) and "e-sports" (green dots) are more mixed. The visual spread confirms that most "e-sports" related words concentrate near the neutral point, indicating both enthusiasm and caution (Figure 4).

The negative sentiment is further supported by keywords such as "excessive" (TF-IDF 0.003) and "control" (TF-IDF 0.002) as in Table 5 which highlight the participants' concerns about overindulgence and the need for discipline. Additional stress-related terms such as "pressure," "issues," "tense," and "decline".

This suggests that the academic strain the students experience is often associated not with gaming itself, but with poor time management and external expectations as displayed in Table 6.

Table 6. Negative emotion keywords related to e-sports

Word	Word Frequency	Number of Items	TF-IDF
Pressure	6	5	0.003
Over	4	3	0.003
No	3	3	0.002
Occupation	2	2	0.002
Reduce	2	2	0.002
Decline	2	2	0.002
Control	2	2	0.002
Issues	2	1	0.002
Tense	1	1	0.001
Brief	1	1	0.001

This duality is also captured in the interview data. One participant noted that: *"Moderate gaming can enhance reflexes, but schools need to provide time management guidance."* Such comments illustrate the coexistence of optimism about e-sports' developmental value and concern about its potentially disruptive effects. Therefore, educational interventions should aim to strike a balance between fostering skill development and promoting self-management among students.

5. Discussion

This study aims to examine how digital competence influences university students' professional competence through the mediating roles of LA and LE, while also exploring the role of e-sports as an emerging digital practice in this developmental process. The findings of this study offer important insights into how students perceive the role of e-sports practice in shaping their learning and self-perceived PC. The proposed sequential mediation model (DL → LA → LE → PC) is supported by the quantitative data affirming prior research that highlights the motivational and behavioral dimensions of digital literacy [25], [30].

Findings in this study align with work by [13] where multidimensional nature of engagement is emphasized. This study shows that students' learning attitudes and behavioral engagement serve as critical pathways through which DC influences their perceived PC. Findings from the qualitative data reinforces this connection.

Frequently mentioned positive terms like "improve," "ability," and "focus" from sentiment analysis reflect students' recognition of how digital environments can support cognitive development and confidence. This is supported by [23] and [37] who found that students with higher digital learning readiness including technical proficiency, self-regulated learning, and motivational belief demonstrated greater academic engagement and adaptation during the transition to college. This demonstrates the broader role of DC in fostering perceived learning capability.

Meanwhile, the polarised sentiment distribution around e-sports ranging from -4 to 4 suggests that students hold ambivalent views. While they acknowledge the strategic and collaborative value of gaming, they also express concern over time management and academic pressure. These concerns aligned with study by [38]. They also found that gaming can improve problem-solving but may also pose risks when not well managed. As such, it was found that keywords such as "pressure," "control," and "issues" reveal underlying tensions that reflect the emotional complexity of digital engagement. Such findings support [39] who proposed embedding digital literacy directly into curriculum design to enhance student engagement and promote critical thinking. Their study highlighted the need for structured digital learning environments that support not only skill development but also self-management and reflective practice particularly relevant in contexts like e-sports where engagement can easily become excessive without proper guidance.

The present study suggests that digital practice like e-sports is not just for entertainment, but are emotionally and educationally meaningful. When e-sports are used in a well-planned learning environment, they have the potential to help students build professional skills. While the sequential mediation model addresses the core mechanisms where DC fosters development of PC through LA and LE, the findings on e-sports add useful insights. These provide insights into how students' informal digital practices like gaming can support formal learning.

6. Conclusion

Overall, this study bridges theoretical, methodological, and practical domains. It shows why it is important to include both emotional and behavioral factors when studying digital competence. By using a mixed-method approach, the study captures both broad patterns and deeper student experiences. Through both quantitative and qualitative data, the research not only examined the relationship between digital competence and professional competence, but also explored the underlying factors, contextual influence and experiences of students that drive this transformation.

Employing a sequential mediation model analyzed through structural equation modelling, the findings confirmed the mediating roles of learning attitude and learning engagement in the capability transformation process. These results demonstrated the complex pathways through which digital competence translates into professional competence. Both positive learning dispositions and active engagement played significant roles in this process. On the other hand, the qualitative interview data provided valuable insights into the potential and challenges associated with e-sports as a context for developing professional competence. Students' narratives highlighted how taking part in e-sports nurtured teamwork, advanced abilities, and strategic thinking. However, findings in this study also brought to light the associated challenges such as time management and the need for supportive learning environments.

Collectively, these findings contribute to a deeper understanding of the multifaceted role of digital competence in shaping students' professional development in contemporary higher education. It also shows that proactive preparation in professional competence development is possible with curriculum refinement and e-sports participation. It also encourages educators and policymakers to see both the benefits and challenges of new digital practices such as e-sports. These insights lay the groundwork for more inclusive, responsive, and skill-focused approaches to digital education within higher learning environments.

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