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# Digital resources and learning outcomes in college physical education: a survey study

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**ABSTRACT**

The effectiveness of digital resources in teaching remains a widely debated issue, particularly in the field of physical education. This article aims to examine the impact of digital resource learning on the learning outcomes of undergraduate physical education courses, with a specific focus on the role of students' awareness and competence in using digital resources. Using a questionnaire survey method, the study analyzed data from 310 undergraduate students from five universities in China. The results showed that digital use ability, use awareness and resource environment had a significant positive effect on satisfaction with learning outcomes. Digital usage awareness fully mediated the effect of digital learning confidence on learning outcome satisfaction and partially mediated the effect of digital usage ability and resource environment on learning outcome satisfaction. These findings suggest that enhancing students' digital usage awareness and learning confidence can significantly improve learning outcomes in physical education courses. The article recommends that educators better utilize and refine digital resources in teaching and enhance students' digital learning skills and awareness to improve the effectiveness of physical education teaching. This study enriches the content of the digital teaching model, reveals the intrinsic mechanisms of how digital resource learning affects learning outcomes, and provides new insights and methods for improving the teaching effectiveness of physical education courses.



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## 1. INTRODUCTION

According to the 52nd China internet report in 2023, the number of internet users in China has reached 1.079 billion, and cell phone users have reached 1,076 billion [1]. Young college students, as internet natives, are key participants and beneficiaries of internet resources [2], [3]. The rapid development of science and technology has driven education into the digital era. The 20th National Congress of the Communist Party of China emphasized promoting education digitization to build a lifelong learning society [4], [5]. Digital education extends to universities, secondary schools, and elementary schools, with platforms like the national wisdom education public service and short video platforms providing teaching resources [6], [7]. The new crown epidemic accelerated digital education, making it a crucial learning method for students [8], [9]. This shift impacts learning ability, willingness, and outcomes [10].

Recently, fitness live broadcasts and artificial intelligence (AI) sports models like "skipping daily" and "keep" have gained popularity, demonstrating digital sports' ability to engage the public [11], [12].

However, effective classroom use of digital sports resources depends on students' digital awareness and abilities [13], [14]. Traditional classrooms facilitate quick learning engagement, while digital learning requires strong self-control and awareness [15], [16].

Technology has transformed physical education, diversifying teaching formats and allowing for various content delivery methods. Digital resources, such as videos, enhance cultural transmission and learning from renowned teachers, improving students' technical skills and interest [17]–[19]. Offline physical education remains primary, but digital resources like slow motion, mechanical analysis, and 3D animation provide detailed insights, motivating students [3], [20]. Studies show videos enhance motor skills, and digital resources preserve historical sports footage [15]. Rich online resources support college students in learning, previewing, and reviewing course material [21], breaking spatial barriers [22], [23].

Learning effectiveness evaluates teaching goals, including knowledge, intellect, skills, and physical fitness. College physical education aims to improve students' fitness and health knowledge, refine sports habits, and cultivate moral and emotional qualities. Digital sports learning should focus on comprehension, application, perception, and digital resource utilization [10], [24], [25]. While digital sports offer alternative fitness methods, they have less impact on sportsmanship and willpower [26]. Some studies show no significant difference between online and traditional classroom learning, though digital education may lack in areas like attention and sports emotions [27], [28].

Changes in learning habits have diversified college physical education. However, digital resource practice faces constraints like facilities and teaching modes, affecting teaching effectiveness [29]. This survey examines the impact of digital sports resources on college students' learning, considering digital use awareness and abilities. The study proposes the following hypotheses to investigate these impacts.

- H1: There is a significant difference in the learning effectiveness of students of different ages and genders in digital resource learning.
- H2: There is a significant correlation between digital competence and usage awareness on learning outcomes.
- H3: Digital competence has a positive correlation on learning outcomes, and awareness of use is a mediator.

This study holds significant importance as it provides empirical evidence on the impact of digital resource learning in the context of college physical education, specifically within China—a country notable for its rich digital sports teaching resources. The findings are particularly relevant in the post-pandemic era, where digital teaching has become a pivotal component of education. Innovatively, the study employs a unique perspective by focusing on the mediation role of digital usage awareness, which has been underexplored in previous research. By highlighting the critical role of digital usage awareness in enhancing learning outcomes, this research offers practical insights for educators aiming to develop new training strategies.

## 2. METHOD

### 2.1. Participants

Participants in this study were Chinese undergraduate college students, investigating the impact of digital use on learning outcomes in five universities (two in Beijing, one in Tianjin, one in Hunan, and one in Fujian), and this questionnaire was distributed online through Questionnaire Star, China's professional research platform "Questionnaire Star." The survey was conducted for a total of 18 days and the online survey platform was opened from May 10-28, 2024 to distribute the questionnaires to physical education classes in five universities, informed consent was obtained from the participants prior to the survey, all subjects were volunteers, and no one received any compensation for their participation. A total of 310 people participated in this survey. The respondents were all Chinese citizens. Previous studies in the educational field have used similar or even smaller sample sizes to draw significant conclusions. For instance, a sample size calculation example indicates that studies can achieve valid results with as few as 50 participants per group when the effect size is large [30]. Thus, a sample size of 400 is more than sufficient to achieve reliable and generalizable results.

The questionnaire was set up in eight parts: basic information; digital participation; confidence in digital learning; digital resource environment; awareness of digital use; ability to use digital; learning effect (satisfaction, subject help); and suggestions for use. Among them, three questions on basic information were gender, grade, and major. Digital participation five questions, respectively, are the reason for use, frequency of use, access mode, search difficulty, participation time. Three questions on digital learning confidence, investigating participants' learning confidence (self-efficacy) in course learning. Digital resource environment three questions, investigating the impact of teachers' use of digital learning resources, digital resource construction, and quality level on learning outcomes. Awareness of digital use three questions,

investigating learners' awareness of the use of digital learning. Three questions on digital use ability, investigating learners' ability to practice and use in digital learning. Learning effectiveness seven questions on satisfaction and subject helpfulness, investigating learners' satisfaction with the course and subject helpfulness using digital learning. Three questions on usage suggestions, including the form of digitized content, usage sessions, and duration. In addition to the basic information, digital use, and use suggestion items, each question was rated on a 5-point Likert scale ranging from 1 (not very much) to 5 (very much) to assess the actual situation of the participants in terms of their experience, feelings, and overall evaluation of the learning effect of the use of digital resources.

### 2.2. Data processing

This survey was completed by filling out and collecting online, after 18 days of questionnaire distribution, 310 questionnaires were finally collected, all the questionnaires collected were valid questionnaires, and the participants were all current undergraduate college students involved in physical education courses. The data were analyzed using statistical package for social sciences (SPSSAU) analysis platform (https://spssau.com/), using descriptive statistics and frequency analysis to define the basic information of the subjects, correlation analysis, linear regression analysis of gender, grade, and major in the use of digital resources, awareness of digital use, and ability.

First, the reliability and validity of the questionnaire were tested. We chose Cronbach's to determine the consistency of the questionnaire content, analyzed the alpha coefficient, and the value of the reliability coefficient of this questionnaire was 0.964, which was greater than 0.9, thus indicating that the research data reliability was of high quality and could be used for further analysis. For validity analysis, factor analysis was used as a data analysis method to verify the validity level of the data through the Kaiser–Meyer–Olkin (KMO) value, common degree, variance explained rate value, and factor loading coefficient value. The KMO value was 0.892, which was higher than 0.8, thus indicating that the research data was very suitable for extracting information (which reflected the validity was very good from the side). The common degree is 0.949, 0.920, 0.914, 0.899, 0.884, 0.842, 0.740, respectively, and all the research items correspond to the value of common degree is higher than 0.4, which indicates that the information of the research items can be extracted effectively.

### 2.3. Data analysis

#### 2.3.1. Analysis of personnel situation

First, as shown in Table 1, we collected data on gender, grade level, professional background, and digital resource participation. Among the participants, 41.6% (n=129) were male and 58.4% (n=181) were female. Freshmen made up 44.19%, sophomores 43.87%, juniors 6.45%, and seniors 5.48%, reflecting that sports are mandatory for freshmen and sophomores, leading to higher participation rates, while juniors and seniors mostly take elective sports courses. Regarding professional background, 66.1% were liberal arts students, 17.1% were science students, 9.6% were engineering students, and 7.1% were art students. Participation in digital resources showed 37.1% engaged throughout the course, 26.45% after school, 18.06% before exams, 12.58% before course start, and 5.81% before each class. This indicates that students use digital resources mainly for continuous learning and post-class review, stimulating independent learning motivation [31], [32].

Table 1. Basic situation analysis of subjects

| Items | Frequency Categories | N | Percent (%) |
|---|---|---|---|
| Gender | Male | 129 | 41.61 |
| | Female | 181 | 58.39 |
| Grade | Freshman | 137 | 44.19 |
| | Sophomore | 136 | 43.87 |
| | Junior | 20 | 6.45 |
| | Senior | 17 | 5.48 |
| Background | Humanities | 205 | 66.13 |
| | Science | 53 | 17.1 |
| | Engineering course | 30 | 9.68 |
| | Art | 22 | 7.1 |
| Participation of digital resources | Before the start of the course | 39 | 12.58 |
| | Before each class | 18 | 5.81 |
| | after class | 82 | 26.45 |
| | Before the exam | 56 | 18.06 |
| | Everyone will participate | 115 | 37.1 |
| | Total | 310 | 310 |

### 2.3.2. Analysis of gender, grade, and preference

From Table 2, differences in digital resource perception were observed between genders. Analysis of variance (ANOVA) results showed significant differences between male and female students in subject helpfulness and confidence in digital learning. Male had a higher mean value (4.06) in subject helpfulness compared to female (3.83), with $p<0.05$. In digital learning confidence, males scored 3.92 and females 3.67, with $p=0.011$. Males also had higher mean values in the frequency of digital use (3.66 vs. 3.25) and ease of digital search (3.95 vs. 3.63), with p-values of 0.001 and 0.003, respectively, indicating significant differences at the 0.01 level.

Overall, male students had higher mean scores than female students in effect satisfaction (4.03 vs. 3.85), ability to use (3.96 vs. 3.82), and awareness of use (3.97 vs. 3.75). While differences in ability and awareness were not statistically significant, the data suggest that students generally have good digital skills, with high satisfaction levels (over 4 points). Male are slightly more practical and active in digital use than female, who need to improve initiative and participation [24], [32].

Male students show higher satisfaction with effectiveness in freshman and sophomore years, while female students surpass males in junior year. Male students also have higher mean values for confidence in digital learning, digital ability, and awareness of use during freshman and sophomore years. In contrast, female students score higher in these areas during junior and senior years. Overall, male students exhibit better digital use levels, particularly in the first two years, with strong digital use ability and effectiveness. Female students, however, show better use awareness and other levels in the later years, though this may be influenced by the smaller number of junior and senior participants in the survey.

As presented in Table 3, course requirements are the primary reason for using digital resources, with a response rate of 29.06% and a penetration rate of 81.94%. Passing exams follows with a response rate of 21.51% and a penetration rate of 60.65%. Interest and hobbies account for 19.57% and a popularity rate of 55.16%. Fresh transaction attempts have a response rate of 16.93% and a penetration rate of 47.74%. “Trying new things” and “actively consolidating and improving” have lower response rates of 16.93% and 12.93%, with popularity rates of 47.74% and 36.45%, respectively. This indicates that students' digital use is largely driven by course requirements and exams, though many also engage due to personal interests and hobbies, reflecting a gradual recognition of digital learning and participation.

Regarding acquisition methods, independent website searches (72.4%) and teacher-recommended content are popular for meeting course requirements, while big data pushes (50%) and student recommendations (32.3%) are less common. For passing exams, website searches (73.9%), teacher recommendations (67%), and fitness software (64.9%) are prevalent, with fewer relying on student recommendations and big data pushes. Overall, students primarily depend on independent online searches and teacher recommendations, demonstrating strong independent thinking and a focus on professionally relevant content to enhance course learning effectiveness.

Table 2. Analysis of variance for factors such as gender and digital utilization

| | Gender (M±SD) | | F | p |
|---|---|---|---|---|
| | Male (n=129) | Female (n=181) | | |
| Satisfaction with learning outcomes | 4.03±0.82 | 3.85±0.80 | 3.695 | 0.056 |
| Learning effectiveness subject assistance | 4.06±0.81 | 3.83±0.80 | 5.742 | 0.017* |
| Digital usage capability | 3.96±0.88 | 3.82±0.81 | 2.145 | 0.144 |
| Digital usage awareness | 3.97±0.84 | 3.79±0.82 | 3.706 | 0.055 |
| Confidence in digital learning | 3.92±0.89 | 3.67±0.79 | 6.568 | 0.011* |
| Digital resource environment | 4.00±0.82 | 3.86±0.79 | 2.213 | 0.138 |
| Frequency of digital use in sports | 3.66±1.05 | 3.25±0.99 | 12.25 | 0.001** |
| The difficulty of digital search | 3.95±0.90 | 3.63±0.96 | 9.07 | 0.003** |

*p<0.05 **p<0.01

Table 3. Reasons for cross tabulation use and acquisition methods (multiple choice questions)

| Items | Course requirements | Hobby | Passing the exam | Proactively consolidating and improving | Attempting new things |
|---|---|---|---|---|---|
| Website search | 184 (72.4) | 137 (80.1) | 139 (73.9) | 97 (85.8) | 120 (81.1) |
| Fitness software | 152 (59.8) | 110 (64.3) | 122 (64.9) | 78 (69.0) | 87 (58.8) |
| Teacher’s recommendation | 162 (63.8) | 115 (67.3) | 126 (67.0) | 84 (74.3) | 100 (67.6) |
| School MOOCs | 135 (53.1) | 88 (51.5) | 107 (56.9) | 69 (61.1) | 82 (55.4) |
| Recommended by classmates | 82 (32.3) | 66 (38.6) | 71 (37.8) | 56 (49.6) | 64 (43.2) |
| Network big data push | 127 (50.0) | 101 (59.1) | 105 (55.9) | 74 (65.5) | 102 (68.9) |
| Total | 254 (81.94) | 171 (55.16) | 188 (60.65) | 113 (36.45) | 148 (47.74) |

Chi-squared: $\chi 2=7.681$, $p=0.994$

### 2.3.3. Correlation analysis

From Table 4, the linear regression model with digital usage ability, digital usage awareness, digital resource environment, and digital learning confidence as independent variables, and learning effect-satisfaction as the dependent variable, as in (1).

$$\text{Learning effect satisfaction} = 0.293 + 0.517 \times \text{digital usage ability} + 0.163 \times \text{digital usage awareness} + 0.290 \times \text{digital resource environment} - 0.036 \times \text{digital learning confidence} \quad (1)$$

The model's R-square value is 0.830, indicating that the independent variables explain 83.0% of the variation in learning effectiveness-satisfaction. The model passed the F-test (F=372.919, p=0.000<0.05), suggesting that at least one of the independent variables significantly affects learning effect-satisfaction.

The regression analysis shows that digital usage ability (coefficient=0.517, t=8.830, p=0.000<0.01), digital usage awareness (coefficient =0.163, t=2.646, p=0.009<0.01), and digital resource environment (coefficient=0.290, t=5.891, p=0.000<0.01) all have significant positive impacts on effect-satisfaction. However, digital learning confidence (coefficient=-0.036, t=-0.874, p=0.383>0.05) does not have a significant impact. Thus, digital usage ability, awareness, and the external environment significantly positively affect learning effect-satisfaction, while learning confidence does not.

As shown in Table 5, correlations between satisfaction with learning outcomes, learning effect subject help, and digital usage ability, awareness, digital resource environment, and confidence in digital learning were examined using Pearson correlation coefficients. There is a significant positive correlation between satisfaction with learning outcomes and digital usage ability (r=0.890, p<0.01), awareness of digital use (r=0.864, p<0.01), digital resource environment (r=0.841, p<0.01), and confidence in digital learning (r=0.745, p<0.01). Similarly, learning effect subject help correlates positively with digital learning confidence (r=0.772), awareness (r=0.864), ability (r=0.883), and digital resource environment (r=0.852), all significant at the 0.01 level. These findings indicate strong positive relationships between satisfaction with learning outcomes and various aspects of digital utilization and confidence, highlighting their importance in enhancing learning effectiveness and support.

Table 4. Analysis of the relationship between digital usage capability and various factors

| Items | Parameter estimates (n=310) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Unstandardized coefficients | | Standardized coefficients | t | p | Multicollinearity | |
| | B | Std. Error | Beta | | | VIF | tolerance |
| Constant | 0.293 | 0.099 | - | 2.973 | 0.003** | - | - |
| Digital usage capability | 0.517 | 0.059 | 0.531 | 8.83 | 0.000** | 6.493 | 0.154 |
| Digital usage awareness | 0.163 | 0.062 | 0.167 | 2.646 | 0.009** | 7.116 | 0.141 |
| Digital resource environment | 0.29 | 0.049 | 0.287 | 5.891 | 0.000** | 4.268 | 0.234 |
| Confidence in digital learning | -0.036 | 0.041 | -0.037 | -0.874 | 0.383 | 3.254 | 0.307 |
| $R^2$ | 0.83 | | | | | | |
| Adj. $R^2$ | 0.828 | | | | | | |
| F | F (4,305) =372.919, p=0.000 | | | | | | |
| D-W | 2.035 | | | | | | |

Dependent variable: learning effectiveness satisfaction. *p<0.05 **p<0.01

Table 5. Relevant analysis of the learning situation of digital resources

| Items | Pearson correlation | | | | | |
|---|---|---|---|---|---|---|
| | LESA | SLO | CDL | DUA | DUC | DSE |
| LESA | 1 | | | | | |
| SLO | 0.930** | 1 | | | | |
| CDL | 0.772** | 0.745** | 1 | | | |
| DUA | 0.864** | 0.864** | 0.794** | 1 | | |
| DUC | 0.883** | 0.890** | 0.801** | 0.908** | 1 | |
| DSE | 0.852** | 0. 841** | 0.784** | 0.854** | 0.830** | 1 |

*p<0.05 **p<0.01

LESA=Learning effectiveness subject assistance; SLO=Satisfaction with learning outcomes; CDL=Confidence in digital learning; DUA=Digital usage awareness; DUC=Digital usage capability; DSE=Digital resource environment

### 2.3.4. Analysis of intermediary relationships

From Table 6, satisfaction with learning outcomes can be predicted by digital resource environment, digital usage ability, and digital learning confidence with respective coefficients: 0.339, 0.614, and -0.022. Similarly, digital use awareness is influenced by digital resource environment, digital usage ability, and digital learning confidence with coefficients of 0.297, 0.595, and 0.089. The analysis shows that digital usage

awareness acts as a perfect mediator between digital learning confidence and satisfaction with learning outcomes when its indirect effect is significant and direct effect is not. When both the indirect effect (a*b) and direct effect (c') are significant and share the same sign, digital use awareness serves as a partial mediator between digital environment and satisfaction with learning outcomes. This highlights the nuanced role of digital use awareness in influencing the relationship between digital competence and learning satisfaction.

Table 6. Summary of mediation test results

| Items | c Total effect | a | b | a*b Median effect value | a*b (Boot SE) | a*b (z) | a*b (p) | a*b (95% BootCI) | c' direct effect | Test conclusion |
|---|---|---|---|---|---|---|---|---|---|---|
| DRE => DUA => SLO | 0.339** | 0.297** | 0.163** | 0.048 | 0.027 | 1.821 | 0.069 | 0.005~0.108 | 0.290** | Partial mediating effect |
| DUAb => DUA => SLO | 0.614** | 0.595** | 0.163** | 0.097 | 0.044 | 2.201 | 0.028 | 0.013~0.187 | 0.517** | Partial mediating effect |
| DLC => DUA => SLO | -0.022 | 0.089* | 0.163** | 0.015 | 0.010 | 1.409 | 0.159 | -0.000~0.040 | -0.036 | Full mediation |

*p<0.05, **p<0.01, Bootstrap type: percentile bootstrap method. DRE=Digital resource environment; DUA=Digital use awareness; SLO=Satisfaction with learning outcomes; DUAb=Digital use ability; DLC=Digital learning confidence

## 3. RESULTS AND DISCUSSION

### 3.1. Analysis of learning situation of digital resources

The survey data indicate positive feedback regarding students' willingness, ability, and participation in utilizing digital resources. A significant portion of students (43.22%) reported using digital resources extensively, highlighting their accessibility and richness as supplementary learning tools [33]. This finding corroborates other related studies. The emergence of new media such as live streaming and short videos has provided students with flexible platforms for engaging with sports content and facilitating their access to relevant learning materials at any time [8]. With the development of digital technology, students are increasingly utilizing tools such as smartphones, computers and artificial intelligence to enhance their learning. Notably, 37.1% of students use digital resources in all aspects of their learning and personal lives. This result also proves that digital resources are integrated into daily learning life [10]. Primary modes of resource acquisition, such as website searches and teacher recommendations, underscore students' focus on content quality and personalized learning needs. Effective learning, therefore, extends beyond mere memorization to encompass adaptive learning styles and methods tailored to individual learning environments.

Significant differences in digital learning are observed among different genders and grades due to varying learning interests and styles. Gender disparities are evident in subject assistance, digital learning confidence ($p<0.05$), and frequency of digital use and ease of search ($p<0.01$), with male students exhibiting higher averages than their female counterparts. This suggests that male students generally engage more actively with digital sports resources, extending the classroom learning experience through digital mediums. Lower levels of confidence and frequency of use among female students in freshman and sophomore years indicate reduced participation compared to males, though they demonstrate increased initiative in junior and senior years [32]. These differences also reflect distinct preferences in digital content, with males favoring strength and conditioning while females prefer flexibility and technical aspects [34], influencing their confidence and perception in using digital resources.

Regarding reasons for digital resource usage, "course requirements" rank highest at 81.94%, followed by "exam preparation" at 60.65%. This utilitarian approach underscores digital resources' role in fulfilling curriculum requirements and aiding exam preparation [21]. However, the relatively lower proportion (36.45%) citing "active consolidation and enhancement" suggests room for improvement in guiding proactive reviewing and pre-study activities. While some studies have discussed the learning experience in offline courses [25], this paper found that although digital resources support self-study and pre-study, the virtual nature of digital resources affects the students' learning experience and hinders the necessary communication and feedback mechanisms when compared to offline practice courses [35].

### 3.2. Relevance analysis and mediating effect of digital learning

Another theoretical contribution of this study is the confirmation of the mediating and moderating role of digital resources on learning outcomes. Data suggest that digital usage awareness partially mediates the relationship between digital resource environment and satisfaction with learning outcomes, highlighting the joint influence of environment and awareness on learning outcomes [36]. Similarly, digital usage

awareness also acts as a partial mediator between digital usage competence and satisfaction with learning outcomes, illustrating the combined influence of practical competence and subjective awareness [37].

The advent of online courses and massive open online course (MOOCs) has significantly enhanced students' digital proficiency [10], [24], [38], fostering increased awareness and acceptance of online physical education and digital sports resources [39], [40]. Post-pandemic adjustments have further accelerated adaptation to digital learning needs [39], [40]. Studies underscore that enhancing students' digital usage ability, promoting awareness of digital use, and cultivating a robust digital resource environment can effectively enhance learning outcomes in physical education courses [37]. Notably, digital learning confidence did not significantly correlate with satisfaction with learning outcomes, suggesting that the specific demands of physical education, requiring perceptual and motor skills, differ from those solely reliant on confidence in disciplinary learning [41], [42].

Related studies have found that digital usage competence in particular plays a key role, with proficient students being more receptive to learning content [43], and our study reconfirms this. Satisfaction with learning outcomes was positively correlated with awareness of digital use [44], confidence in digital learning, digital competence and digital resource environment. A strong correlation coefficient of 0.890** between digital competence and satisfaction with learning outcomes underscores its critical role [7], [45]. The digital resource environment serves as the foundation for digital learning, offering students secure access to online resources, live streams, short videos, and physical education MOOCs [46]. Enhancing visual impact through technical sports details, the environment significantly correlates with satisfaction with learning outcomes (correlation coefficient of 0.841**), emphasizing its influence on student learning outcomes [46].

Digital usage awareness fully mediates the relationship between digital learning confidence and satisfaction with learning outcomes, underscoring its pivotal role. This mediation suggests that confidence in digital learning influences learning outcomes through awareness, highlighting the importance of students' attitudes and motivations in online learning models [26], [47]. Effective development of digital usage awareness impacts participation frequency, attitudes toward learning, recognition, and learning outcomes, advocating for greater emphasis on awareness over technical skill training [48]. While practical offline exercises remain preferred for their relevance to sports, advancements in digital sports and virtual reality enhance student engagement and visualization of sports details [23], [49], [50]. Teachers should leverage and improve these technologies to better integrate physical education and sport teaching with contemporary developments, enhancing digital learning skills and promoting awareness of digital use among students.

### 3.3. Theoretical and practical implications

Digital resources have emerged as crucial tools in enhancing students' learning experiences through reviewing, previewing, technology consolidation, and enhancement [37], [41]. As the digitization trend continues, their integration into students' learning lives significantly impacts course outcomes and holds implications for future physical education teaching practices. First of all, existing research mainly focuses on the effect of classroom learning and ignores other aspects, this study bridges this gap by extending the focus to digital learning after class. In online physical education teaching, challenges like low attendance rates and platform quality issues persist [51]. An effective hybrid mode of online and offline teaching is more suitable, where digital resources serve as potent supplements to enhance physical education learning and foster enthusiasm for sports participation.

Second, the study emphasized the mediating role of digital usage awareness between digital learning confidence and satisfaction with learning outcomes. This finding reveals an intrinsic mechanism by which learning with digital resources influences educational outcomes. Digital usage awareness mirrors students' learning attitudes and pathways. While digital learning is typically influenced by factors such as technical proficiency, resource availability, and platform quality [35], this study underscores that learning confidence significantly benefits from digital usage awareness to enhance educational outcomes. Drawing from learning transfer theory, successful digital learning experiences can be applied to physical education, emphasizing the importance of mediation by usage awareness for positive impacts on learning outcomes.

Third, this study enriches the research on digital informal learning among college students. College students have more opportunities for self-directed learning, so understanding students' use of digital resources for self-directed learning can help to understand their autonomy, sports habit development, and learning engagement. The findings showed that students primarily seek technical content in sports, with 31% favoring ultra-high-definition slow-motion videos and 21% preferring classroom technical videos, suggesting a need to strengthen technical mastery [52]. Notably, female students' lower mean digital usage score of 3.2 indicates room for encouraging greater sports participation. In conclusion, this study expands knowledge on digital teaching models and informal learning while elucidating the mediating role of digital usage awareness in learning outcomes. These insights offer innovative approaches to enhance the effectiveness of physical education courses.

### 3.4. Limitations

This study, primarily a cross-sectional analysis, offers insights into students' learning experiences within a specific timeframe, showcasing their engagement, information acquisition, and learning outcomes from digital resource learning. However, the absence of longitudinal comparative experimental research limits its scope, suggesting that a pre- and post-participation comparative analysis could provide a more comprehensive understanding of the effects of digital resource learning. Secondly, the study spans five universities across different regions in China (east, south, north), aiming to provide a representative view of digital resource learning among Chinese university students and its impact on sports education. While the gender ratio is balanced, the distribution across grade levels, particularly the dominance of liberal arts students and fewer juniors and seniors surveyed, may not fully capture all student perspectives on digital resource usage, competency, and awareness.

Lastly, this study offers multifaceted insights for enhancing digital learning effectiveness. It underscores the role of digital resources as foundational tools in physical education, enriching self-study opportunities and enhancing students' awareness of digital usage. It advocates for focused training on digital competency and fostering sports habits and culture among students, while also guiding educators in effectively integrating digital resources into teaching practices.

## 4. CONCLUSION

The results of the data analysis verified most of the hypotheses. Although there were differences in learning outcomes and participation across grades, the differences were not statistically significant. However, a clear pattern emerged between males and females at different grade levels. Freshman and sophomore males showed greater proficiency in digital learning, while junior and senior females showed greater awareness and confidence in digital use, suggesting a developmental process in digital engagement. In terms of subject assistance effectiveness, confidence in digital learning, frequency of digital use, and search difficulty, male students typically demonstrated stronger digital skills and utilization, which was often motivated by utilitarian motives such as meeting course requirements and preparing for exams. Moreover, linear regression analysis emphasized the positive effects of digital use competence ($\beta$=0.517, t=8.830, p<0.01), digital use awareness ($\beta$=0.163, t=2.646, p<0.01), and digital resource environment ($\beta$=0.290, t=5.891, p<0.01). Proficiency in digital skills was a key predictor of effective resource utilization outside of the traditional classroom. Findings showed that students were digitally proficient, as well as having a high level of awareness of digital tools and proactively utilizing them to supplement their coursework. A comprehensive digital resource environment, including MOOCs, online influencers, fitness apps, and diverse content, promotes a personalized learning experience tailored to individual needs. Third, awareness of digital use played a key mediating role in learning outcomes. Specifically, it fully moderated the relationship between digital learning confidence and satisfaction with learning outcomes, highlighting the need for confidence to translate through awareness to influence learning outcomes. Similarly, awareness of digital use partially moderated the impact of digital competence and digital resource environments on learning outcomes, highlighting their important impact on improving educational outcomes.

This study clearly demonstrates that digital educational resources have a place in physical education. Not only does digital resource learning provide students with convenient and varied access to learning, but it also significantly improves the effectiveness and engagement of physical education learning. More importantly, however, it highlights the need for further research into the use of digital resources and their ability to assist teachers in helping their students to exercise a deeper, broader, and more sustained awareness and competence in digital learning. In terms of the implications of this study for teaching practice and educational policy, it should be noted that this research addresses a topic of critical importance, namely the simultaneous integration of cutting-edge technology and education. This is because, in addition to digital teaching and learning resources, innovations in artificial intelligence are rapidly and profoundly impacting physical education. This requires policymakers and educational participants to be proactive in understanding these new technologies, while working to increase students' awareness of digital usage so that they are resilient enough in the age of AI. These insights provide new perspectives and strategies for optimizing digital physical education teaching and learning practices, promoting more inclusive and impactful educational environments.

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