

Influence of APP-Assisted Teaching on Teaching Quality in Mobile Learning

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Abstract—At present, a large number of education APPs have been developed and widely applied, making mobile learning one of the more popular learning methods under influence of the epidemic. Undeniably, control of college students is indeed an issue that needs to be considered to prevent non-learning behaviors of students in APP learning. Education APPs are more suitable to assist traditional education and to help teachers' teaching and students' learning. Based on the theory of fragmented learning and activity learning, a questionnaire on the influence of APP-assisted teaching technology on teaching quality of mobile learning was designed, and mediating effect of team interdependence on the influence of APP-assisted teaching technology on teaching quality of mobile learning was measured. Kruskal-Wallis test was used to measure difference between APP usage quantity and teaching quality. Results show that convenience, individualization and immediacy of APP-assisted teaching technology have significant influence on teaching quality of mobile learning. Team interdependence plays a part in mediating effect of APP-assisted teaching technology on teaching quality of mobile learning. Different APP usage quantity samples all show a significant effect on teaching quality ($p < 0.05$). Conclusions have important reference value for learners to rely on education APPs to carry out fragmented, efficient and personalized learning, to improve education APPs as a teaching method to assist traditional teaching, and to avoid learners falling into "technology-oriented" misunderstanding of over-reliance on APPs for learning.

Keywords—APP-assisted teaching technology, mobile learning, teaching quality, questionnaire survey, mediating effect, Kruskal-Wallis test

1 Introduction

With the development of mobile Internet information technology, the trend of intelligence and popularization of mobile terminals is more obvious. Many learners are used to mobile learning with mobile phones and tablet computers, which enables them to have ample time and flexible space for effective learning. With the comprehensive introduction of mobile terminal devices into learners' daily learning, the number of education APPs is also increasing year by year, and more learners gradually like education APPs for mobile learning. Theoretically, mobile learning means that learners rely on mobile devices to learn curriculum systems. Learners can learn flexibly and

in various ways at any time and place. Learning by educational APPs can satisfy time emotional exchange and real-time communication between learners and teachers, and between learners. At present, many universities in China have introduced relevant management measures for mobile learning based on education APPs. In essence, education APP-assisted teaching technology can assist college students to build their own professional knowledge-learning space, to transform the traditional passive receiving mode of teaching into a learner-oriented mode of knowledge creation. Teachers in higher education have changed from lecturers to assistants in learning knowledge and guides in improving skills. At the same time, students also change from original passive acceptance of knowledge to learning identity of active inquiry. With the support of education APPs, higher education teachers have better information technology support for mobile teaching. APP-assisted teaching is not only conducive to encouraging college students to actively explore knowledge, giving play to students' subjective initiative, realizing resource sharing between teachers and students or between students, and constructing learners' perfect knowledge system. College students use education APPs for mobile learning. They can better operate intelligent mobile terminal devices according to learning progress, knowledge difficulty, time allocation and other conditions. By carrying out mobile learning through education APPs, learners can complete their fragmented, efficient and personalized learning processes, and their higher-order thinking ability can also be significantly improved comprehensively.

Most universities can make use of Internet technology and application of education APPs in mobile learning, which can create a more efficient teaching environment. Assisted teaching is leading the future development direction of education. College students' learning habits and way of thinking have been gradually changed by mobile Internet, and future model of higher education will also be changed by this new technology. With help of mobile Internet, teaching resources have been fully integrated. More enriched mobile learning platforms are presented in front of students. Meanwhile, the limitation of time and space is broken. Students can make reasonable and efficient use of fragmented learning time, study anytime and anywhere, and obtain more abundant learning resources with higher learning efficiency. With the development of Internet technology and the growing maturity of mobile technology teaching, mobile learning has become a convenient and flexible way of learning preferred by Chinese learners.

2 Theoretical basis and hypothesis development

2.1 Theoretical basis

Fragmented learning theory is the basic theory of this study. This theory holds that some learners can learn through multimedia anytime and anywhere in daily social life without being limited by time and place. In fragmented learning mode, students can choose their learning courses, learning methods, learning progress and other content according to their current learning situation. Fragmented learning can promote learning to adopt a more autonomous learning style and enhance degree of knowledge accumulation. At the same time, learners in this learning mode can deal with learning content in fragmentary and miniaturization. Learners' learning time is not limited, and

fragmented time and learning space can be seamlessly connected. Individual learning behavior of learners is discontinuous and diverse, which can promote leap of learning thinking and fragmentation of individual attention, and reflect a better and diversified learning form. Education APPs can meet the learning needs of users, enable learners to make scientific and systematic use of daily fragments of time, and make learning anytime and anywhere a learning habit. Mobile learning software of smartphones conforms to characteristics of fragmented learning theory. APP-assisted teaching can enable learners to learn comprehensively and deeply in process of teacher teaching and learner learning.

Meanwhile, the activity learning theory proposed by Jonassen et al. [1] is also an important theoretical basis for this study. The application of APP tutoring teaching technology is essential to forming a problem-centered learning team. With the help of external experts and team members, individuals learn spontaneously, constantly question and share experiences, and finally solve difficulties through activity learning, which is simply to learn skills in practice. Activity learning is a form of mobile learning. This theory provides theoretical support for mobile learning. According to this theory, self-consciousness and activity of individual learning interact and depend on each other. Activity learning theory has become a brand new form, and learner learning efficiency has become the key aspect.

2.2 Hypothesis development

With the development of information technology, it is difficult for college students to study without the Internet and smartphones. There are constantly learning APPs being developed on smartphones. Education APPs undoubtedly provide students with more opportunities and ways to learn. College teachers can adapt to social development, and education APPs will inevitably become a tool to help college students increase their interest in learning, enrich teachers' teaching resources and improve teaching methods. As for how education APPs affected teaching quality, Papadakis et al. [2] showed in their research that visual programming environment supporting program construction through drag-and-drop interface was one of the most commonly used coding tools to teach novice programmers, and effectiveness of programming could be effectively taught and learned among secondary education students through aid of programming education APPs. Shahrokni [3] believed that the interactive video function of APPs could improve learners' learning motivation. Zhang et al. [4] believed that APP teaching reflected a new teaching model with teachers and students as the main body, which could solve various practical problems in education of teachers and students, provide students with more ideological and political learning resources, and increase their learning interest and time. Abulude et al. [5] held that use of education APPs could improve teachers' resource allocation ability for mobile learning. Corkett et al. [6] believed that technology in form of iPad, iPod, and desktop computer applications enabled teachers to realize knowledge integration and that results showed that teachers' self-efficacy and technology perception were significantly improved before and after development of APP-based multi-literacy teaching plans. Norton et al. [7] combined mobile technology with GIS for field data collection and investigated its impact on student engagement and perception of integrating technology into environmental science curricula.

Analysis before and after survey indicated a strong link between inclusion of geospatial technology as part of curriculum and student participation. Grose et al. [8] developed an APP that allowed wide access to e-learning resources, and research results showed that more high-quality courses could enable learners through APP. It had been widely used worldwide and incorporated into medical school curricula of various institutions. Medical education could be improved through application of education APPs. An et al. [9] showed that using APP inventor to design appropriate programming education plans could make learners feel satisfied with programming education, and proposed a revised programming education plan for primary and secondary schools using APP inventor. The main result of the study by Hoareau et al. [10] was that the social context of the school was an important factor to be considered when studying teachers' beliefs and acceptance of technology. Giani et al. [11] analyzed the influence of mobile applications on university achievement of developmental education students. Results showed that using APP significantly improved students' performance in developing educational outcomes and slightly improved mid-college adherence and performance, but did not affect academic attainment over study time frame. Pombo [12] developed an interactive mobile augmented reality (AR) application to create attractive and effective strategies for interdisciplinary learning. Callaghan et al. [13] showed that preschool education adopted many applications, and a variety of education APPs significantly increased early childhood learners' interest in learning. Liu et al. [14] showed that APPs learners could improve their learning methods and efficiency by getting feedback immediately in process of the interview. Harlick et al. [15] believed that application of education APPs could significantly improve learners' interest in learning. According to Hoplock et al. [16], as a means to assist teaching, applications could significantly improve learners' cognition and interest. It could be concluded from the existing research literature that APP-assisted teaching had been widely promoted and applied worldwide. Its main advantages were as follows. APP-assisted teaching could give learners more flexible and varied learning feelings, stronger immersion and more full learning motivation. Therefore, based on four characteristics of APP-assisted teaching technology in education, APP-assisted teaching technology had strong advantages over traditional classroom teaching in convenience, individuation, interaction, and immediacy. The following four research hypotheses are proposed.

H1: Convenience of APP-assisted teaching can significantly improve the teaching quality of mobile learning.

H2: Individuation of APP-assisted teaching can significantly improve the teaching quality of mobile learning.

H3: Interaction of App-assisted teaching can significantly improve the teaching quality of mobile learning.

H4: Immediacy of App-assisted teaching can significantly improve the teaching quality of mobile learning.

At the same time, as APP-assisted teaching technology required learners to strengthen interactive learning, teachers generally adopted group teaching methods. Therefore, this study considered team interdependence as a mediator variable. As for how team interdependence affected teaching quality, Pepin et al. [17] mainly believed that team

learning could improve learning effectiveness of nurses. Jeong [18] showed that task interdependence in team learning had the most direct and indirect impact on team performance. Sebok-Syer et al. [19] showed that member interdependence patterns in a team were mainly influenced by the performance of trainees and supervisors. Skilton et al. [20] found that the experience of interdependence among students' team members could enhance students' integrated learning, and interdependence could be decoupled from project complexity. Therefore, hypothesis H5 is proposed.

H5: Team interdependence plays a mediating role in APP-assisted teaching technology in teaching the quality of mobile learning.

3 Methodology

3.1 Questionnaire design

In this study, a questionnaire is designed to study the influence of APP-assisted teaching technology on teaching quality of mobile learning. This questionnaire is self-designed and compiled according to the results of related education and teaching reform tasks undertaken by the research group. The questionnaire includes the following three aspects. The first aspect is the basic information of six aspects of respondents, including gender, grade, major, APP type, usage quantity of APPs, daily usage duration of APP. The second aspect is to measure four aspects of APP-assisted teaching technology, including convenience, individuation, interaction and immediacy of education APP. 5, 4, 4, and 4 questions are used respectively to measure. At the same time, teaching quality is measured by research results of Ramsden [21] and 5 questions in the research conclusions. Since mobile learning makes the learner subject of learning, and especially because interaction of education APPs makes the learner a team, team interdependence as a mediating variable is researched in this study. 3 questions in the questionnaire of Pearce et al. [22] are adapted as measurement questions of mediating variables in this study. All questions are measured using a 7-point Likert scale.

3.2 Research objects

APP-assisted education requires learners to have high self-study ability and self-discipline. Therefore, this study selects relevant undergraduate students from a 211 university in Beijing, where higher education is relatively developed, to conduct a questionnaire survey. At present, many colleges and universities in Beijing are comprehensively promoting the construction of information-based courses, and have gained a lot of valuable experience for other colleges and universities in China in aspects of education and teaching reform concept and operation mode. In this study, questionnaire survey software is used to make an electronic version of the questionnaire, and QR codes and website links are distributed to students of relevant universities through Wechat and QQ for investigation. Excel is used to make statistics on the data obtained and made into a table as shown in Table 1, which made the data more intuitive.

Table 1. Descriptive statistical results of basic information of the investigation group

Name	Option	Answer the Number of Measurement Questions	Frequency	Percentage (%)
Gender	Male	1	148	63.25
	Female	2	86	36.75
Grade	Freshman	1	45	19.23
	Sophomore	2	85	36.32
	Junior	3	71	30.34
	Senior	4	33	14.1
Major	Educational technology	1	28	11.97
	Preschool education	2	67	28.63
	Physical education	3	75	32.05
	Sports training	4	41	17.52
	Primary education	5	23	9.83
APP type	E-book reading APP	1	29	12.39
	Enlightenment APP	2	54	23.08
	Foreign language learning APP	3	22	9.4
	Examination APP	4	33	14.1
	Education guidance APP	5	40	17.09
	Challenge answering APP	6	56	23.93
Usage quantity of APP	1 item	1	4	1.71
	2 items	2	9	3.85
	3–5 items	3	64	27.35
	6–8 items	4	85	36.32
	More than 8 items	5	72	30.77
Daily usage duration of APP	Within 1 hour per day	1	35	14.96
	1–2 hours per day	2	63	26.92
	2–3 hours per day	3	73	31.2
	3–4 hours per day	4	31	13.25
	4–5 hours per day	5	20	8.55
	More than 5 hours per day	6	12	5.13

4 Results analysis

4.1 Reliability and validity analysis

Firstly, commonly used Cronbach’s α coefficient is used to test the reliability of the questionnaire.

Table 2. Reliability test result

Variable Type	Variable Name	Number of Measurement Problems	Cronbach’s α Coefficient	Cronbach’s α Coefficient
Independent variable	Convenience	5	0.933	0.962
	Individuation	4	0.918	
	Interaction	4	0.909	
	Immediacy	4	0.968	
Dependent variable	Teaching quality	5	0.958	
Intervening variable	Team interdependence	3	0.947	

As can be seen from Table 2, Cronbach’s α coefficient is 0.962, and Cronbach’s α coefficient of each variable is also higher than 0.9, indicating that the reliability is very good.

Table 3. Index results of model AVE and CR

Factor	AVE Value	CR Value
Convenience	0.737	0.933
Individuation	0.749	0.921
Interaction	0.724	0.913
Immediacy	0.875	0.965
Teaching quality	0.855	0.946
Team interdependence	0.834	0.962

As can be seen from Table 3, AVE values corresponding to a total of 6 factors are all greater than 0.5, and CR values are all higher than 0.7, which means that analyzed data has good aggregation (convergence) validity.

Table 4. The KMO value and Bartlett sphericity test

	Convenience	Individuation	Interaction	Immediacy	Teaching Quality	Team Interdependence
Convenience	0.859	–	–	–	–	–
Individuation	0.498	0.866	–	–	–	–
Interaction	0.498	0.572	0.851	–	–	–
Immediacy	0.698	0.452	0.519	0.935	–	–
Teaching quality	0.587	0.499	0.598	0.748	0.925	–
Team interdependence	0.521	0.383	0.54	0.622	0.619	0.913

Note: Diagonal numbers are AVE square roots.

As can be seen from Table 4, the AVE square root values of 6 factors are all greater than the maximum value of the absolute value of correlation coefficients between factors, which means that they have good discriminative validity.

Table 5. The KMO and Bartlett tests

The KMO Value		0.926
Bartlett sphericity test	Approximate chi-square	7039.539
	df	300
	P value	0

As can be seen from Table 5, the KMO value is 0.926, which is larger than 0.6, and the data can be effectively extracted. The validity analysis passed the Bartlett test, and the corresponding P value is 0.000, less than 0.05, which passes the test.

4.2 Linear regressions

Table 6. Linear regression results

Variable	Standardization Coefficient	t	p	VIF	Adjusted R ²	F
Constant	–	4.003	0.000**	–	0.868	F(4,229)=52.203, p=0.000
Convenience	0.279	3.401	0.001**	2.954		
Individuation	0.215	3.510	0.001**	1.643		
Interaction	0.082	1.190	0.235	2.057		
Immediacy	0.233	3.008	0.003**	2.638		

Notes: The D-W value is 1.685. * means $p < 0.05$, and ** means $p < 0.01$.

As it can be seen from Table 6, the model passes F test ($F=52.203$, $p=0.000 < 0.05$), and all VIF values in the model are less than 5, which means there is no collinearity problem. And the D-W value is near number 2, indicating that there is no autocorrelation in the model. Hypothesis H1 is true. That is, the convenience of APP-assisted teaching can significantly improve teaching quality of mobile learning. Main reason is that nowadays college students have mobile terminals (such as smartphones, iPads, etc.) for mobile learning. Education APPs installed on mobile terminals make mobile learning more portable. Education APPs allow learners to learn flexibly on their own time. At the same time, teachers of mobile teaching are more flexible and diversified in teaching organization, urging college students to use education APPs to conduct self-learning behaviors such as knowledge previews and knowledge reviews anytime and anywhere [23]. Especially for seniors and juniors, more mobile learning methods are needed to support their portable learning. Meanwhile, in recent years, due to the impact of the COVID-19 pandemic, many college students have been quarantined and confronted with nucleic acid testing during daytime classes, which makes it impossible

for them to concentrate their time and energy on simultaneous learning. Convenience of education APP plays a more powerful advantage across time and space, enabling college students to preview and review knowledge at their own convenient time, which plays an obvious role in promoting teaching quality.

Hypothesis H2 is true. Individuation of APP-assisted teaching can significantly improve the teaching quality of mobile learning. With comprehensive penetration of mobile Internet information technology into the field of education, teaching mode of traditional extensive classroom needs to be combined with more advanced information technology to meet needs of learners to learn anytime and anywhere. In recent years, China's higher education has carried out a lot of reforms. Higher education is an advanced stage for learners to receive education. Therefore, higher education must adopt teaching strategy of teaching students according to their aptitude, so that students can have more personalized learning. Education APPs can make mobile learning and personalized teaching possible, allowing students to customize learning from aspects of learning content, learning time and learning progress. For example, in APP teaching, teachers allow learners to form study groups for discussion by establishing group chats. For example, teachers set learning time to promote learners to learn knowledge at their appropriate time. For example, a personalized error book is created for learners and errors in different chapters are reviewed repeatedly. For example, learners set learning difficulty and other ways to enable learners to conduct more scientific and efficient self-learning under different learning states.

Hypothesis H3 is not true. Interaction of APP-assisted teaching has not significantly improved teaching quality of mobile learning. This conclusion does not hold up depending on conventional understanding of educators. However, a careful analysis shows that potential reason lies in that, due to impact of the epidemic, APP-assisted teaching has been widely carried out since 2019. However, with delay of time, more and more education APPs make learners pay too much attention to knowledge chapter learning in the APPs and lose interest in interactive functions of the APP. However, after three years of global epidemic impact, college students have become tired of similar learning interactions and remain in a state of coping with mutual evaluation of students. This conclusion also focuses on enlightening college teachers. In APP-assisted teaching, it should further increase emotional communication between teacher-student interaction and student-student interaction. Amount of knowledge set for mobile learning should not be too much, and learners should fully enjoy fun of mobile learning and interactive communication.

Hypothesis H4 is true. Immediacy of APP-assisted teaching can significantly improve teaching quality of mobile learning. Immediacy is an important feature of APP-assisted education. For example, education APPs are used to conduct in-class exams. Teachers set several small questions, and learners can see their scores and rankings immediately after answering them, which improves learners' interest in learning. In mobile learning of education APPs, teachers can organize test questions of different difficulty at any time and recombine teaching knowledge points, so that composition of teaching knowledge is more in line with teaching situation and current state of learners.

4.3 Difference of immersion in different VR platforms

Table 7. Mediating effect

	Teaching Quality	Team Interdependence	Teaching Quality
Constant	1.796** (8.205)	1.092** (5.602)	1.434** (6.421)
App-assisted teaching	0.582** (12.109)	0.733** (17.142)	0.338** (4.886)
Team interdependence	–	–	0.332** (4.701)
Adjusted R ²	0.385	0.557	0.436
F value	F(1,232)=146.624, p=0.000	F(1,232)=293.858, p=0.000	F(2,231)=91.031, p=0.000

As can be seen from Table 7, hypothesis H5 is assumed to be true. Team interdependence plays a part in mediating the effect of APP-assisted teaching technology on teaching quality of mobile learning. The main reason is that team interdependence is an inherent feature of mobile learning. In mobile learning, teachers generally adopt group discussion and group learning, which enables learners to help each other cooperate and share resources among team members to complete team tasks. Through teacher organization, interdependence can be used to improve learning efficiency of relevant teams in education APP-assisted teaching. In particular, learners with stronger learning motivation can form an efficient learning team, which will further enhance team interdependence and produce more learning skills such as cooperative division of labor, relevant discussion and common progress, so that teaching quality will be more obvious.

4.4 Analysis of the difference between APP usage quantity and teaching quality

Table 8. Difference between APP usage quantity and teaching quality

	The Median Number of Usage Quantity of APP M(P25, P75) □					Kruskal-Wallis Test (Statistic H)	p
	1.0 (n=4)	2.0 (n=9)	3.0 (n=64)	4.0 (n=85)	5.0 (n=72)		
Teaching quality	7.000 (4.8,7.0)	3.000 (2.0,5.0)	5.000 (4.0,5.0)	5.000 (4.0,6.0)	4.000 (3.0,5.0)	10.227	0.037*

Note: * means $p < 0.05$, and ** means $p < 0.01$.

As can be seen from Table 8, Kruskal-Wallis test statistics are used for analysis. All samples with different APP usage quantity show a significant effect on teaching quality ($p < 0.05$), which meant that different APP usage quantity samples have a different effect on teaching quality. It can be seen that when learners only use one APP for learning, teaching quality is the highest. In particular, when number of learner APPs is 3–5 and 6–8, teaching quality starts to decline gradually. Especially, when number of learner APPs is greater than 8, teaching quality decreases significantly. This conclusion also focuses on enlightening teaching administration departments in colleges and universities. In mobile teaching, different types of APPs should not be used too much, which may cause learners to spend too much time learning operation process of different

education APPs and spend a lot of energy getting familiar with learning skills of APPs. Teaching management departments of colleges and universities should coordinate teachers of courses each semester and encourage teachers to adopt mature, popular and general teaching APPs instead of using different APPs for learning a course, which will make learners waste a lot of time operating different APPs and thus reduce teaching quality.

4.5 Discussion

Compared with traditional university classroom teaching, mobile teaching based on education APPs can improve students' learning motivation. Teachers who implement education APPs-based teaching also carry out more adequate teaching reform. The adoption of education APPs for mobile learning has prolonged duration of college students' learning time and significantly decreased number of students who are distracted in class. The main reason for these behaviors lies in enhancement of students' learning motivation. Teaching based on education APPs creates a challenging learning environment for students, allowing them to solve problems independently and to seek ways to solve problems. Driven by task orientation, students actively participate in learning, not only in the brain but also in the body. Due to portability of education APPs, students can use education APPs to quickly collect, search and share knowledge, study and review anytime and anywhere, which makes learning style of learners more personalized. Education APPs can not only enhance immediacy between teachers and students, but also enhance communication between teachers and students by establishing group chats. However, how to change effective integration of teachers' teaching and students' learning, so that more front-line teachers can apply APP-assisted teaching technology into their teaching, requires more educational practices.

5 Conclusion

Taking scientific and technological means to improve the efficiency of work and study, the education field is playing a leading role. In mobile learning, the new teaching method of education APP-assisted teaching can improve efficiency of mobile learning and make up for shortcomings of traditional classroom. This study designs a questionnaire on influence of APP-assisted teaching technology on teaching quality of mobile learning, and uses Kruskal-Wallis test to measure difference between number of APPs used and teaching quality. Results show that the overall reliability and validity are very good. Convenience, individuation and immediacy of APP-assisted teaching technology have significant influence on teaching quality of mobile learning. Team interdependence plays a part in mediating effect of APP-assisted teaching technology on teaching quality of mobile learning. Different APP usage quantity samples all show significant effect on teaching quality. It is suggested to continue to focus on relationship between APP learners' behavioral engagement and academic performance in the future, influence of composition ratio of different resources such as video, audio and PPT in education APPs on learners' learning involvement, and learners conducting in-depth research on relationship between satisfaction with use of education APPs and learning performance.

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7 References

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