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Application and Exploration of Digital Mobile Learning in Remote Meteorological Training

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Abstract: *The concept of mobile learning has been studied for a relatively long time, but digital mobile learning has only developed rapidly in recent years based on the new network infrastructure and the advancement of smartphone technology. It has gradually become one of the essential learning methods from being an optional one. In 2019, nearly 47% of organizations globally were using digital mobile learning [1], and this number is still rapidly increasing. Digital mobile learning has become the future trend of learning. In 2018, the meteorological department officially launched the "Meteorological Mobile Learning Center". However, due to its independent operation and lack of effective integration with the meteorological remote education and training system, it was discontinued after a period of operation. Currently, the second-generation mobile platform is about to be officially launched. This article discusses the significance, current status, existing problems, and future development prospects of digital mobile learning in meteorological remote training, providing theoretical and factual evidence for the launch of the new platform and the further development of meteorological digital mobile learning.*

Keywords: *Digital, Mobile Learning, Meteorological, Remote Training*

1. Introduction

Numerous meteorological stations across China are situated in remote and challenging locations, where staff members are burdened with substantial workloads and limited opportunities for in-person professional development. Traditional onsite training programs are constrained by logistical factors such as location, timing, and participant capacity. Conversely, remote training platforms are not subject to these limitations, facilitating access to educational resources for employees in isolated areas and promoting the equitable distribution of high-quality training materials. Given the rapid advancements in weather forecasting technologies, continuous professional development is essential for meteorological personnel to stay abreast of emerging knowledge and techniques. The introduction of the e-learning weather education platform in November 2005 has been pivotal, with data from 2006 onward illustrating its utilization, as depicted in Figure 1 (inclusive of statistics up to November 28, 2023).

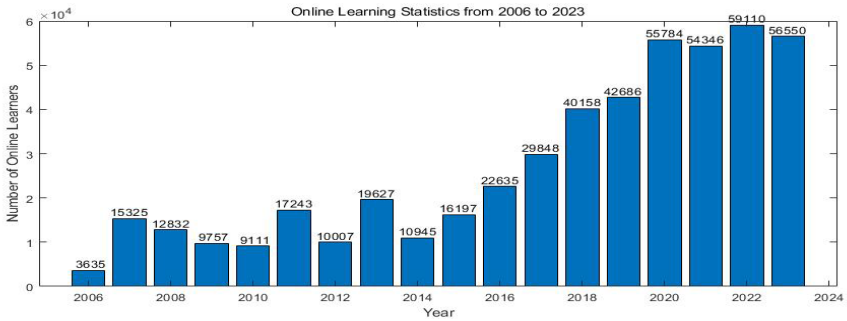

Figure 1: Number of staff members participating in meteorology online learning from 2006 to 2023, demonstrating a steady increase in user engagement over time

Figure 1 depicts the growth in the number of meteorology online learning participants from 2006 to 2023. The growth trajectory accelerated post-2015, coinciding with network enhancements and cost reductions [2] as well as the introduction of specialized data packages [3]. The trend further escalated

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in 2020 due to additional reductions in traffic costs and improvements in internet speed [4], and was amplified by the global pandemic's influence on remote learning adoption [5]. The peak observed in 2020 has sustained, maintaining high participation rates into 2023.

The online learning platform is accessible via web browsers and mobile phones, with the latter referred to as mobile learning. Mobile learning is usually learning with problems, so the purpose of learning is strong, and the learning efficiency will be higher. As the adult education of on-the-job workers, the goal of learning is to improve their personal professional quality and job ability, their learning is personalized learning and better matches the future development trend of online learning [6-7]. In this study, we examine the state of mobile learning in meteorological departments and analyze the associated issues, challenges and outlook of implementing mobile learning.

2. Application and Exploration of Digital Mobile Learning in Remote Meteorological Training

The meteorological department, committed to the principles of continuous education and lifelong learning and keeping pace with the evolution of technology, has proactively developed a mobile learning platform tailored for meteorological professional education. With the advent of the 4G era, initiatives were undertaken to create mobile learning applications, culminating in the launch of the "Meteorological Mobile Learning Center" in December 2018. However, due to developmental oversights that resulted in data silos separate from the original platform, the service was suspended. Now, in the 5G era, an upgraded version of the mobile platform is undergoing testing and operational trials. This revamped application is designed to train users in meteorological operations, featuring user-friendly navigation and modern design to enhance the appeal of learning and provide learners with an improved educational experience.

Digital mobile learning in the meteorological department is structured into two main categories: network Asynchronous autonomous learning and network synchronous live broadcast training.

2.1. Network Asynchronous Autonomous Learning

Network asynchronous learning allows for a flexible arrangement of study times, enabling learning at home, during work breaks, or meal times, where mobile device usage is more likely. Mobile learning diminishes the limitations imposed by geographical location, fostering greater autonomy and flexibility in education [8].

Since 2016, the meteorological department's courseware has supported concurrent learning on both computer and mobile platforms, with adaptive and responsive designs to suit various screen sizes. Even prior to the mobile platform's launch, there was evidence of students utilizing mobile phones to access courses via the web-based platform.

In 2018, the meteorological department took an innovative step by integrating mobile learning with virtual reality technology, creating touch-screen virtual practical training courses. This initiative provided students with mobile learning tools for simulated operations, as shown in Figure 2. This gamified approach to mobile learning transforms traditional training methods and enhances the educational experience, with the touch-screen functionality on mobile devices proving more user-friendly than mouse controls on computers [9].

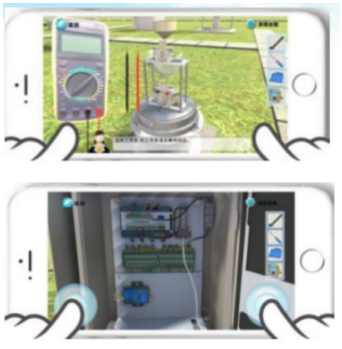

Figure 2: This figure is a screenshot of the virtual training network course of automatic weather station maintenance and maintenance, simulating the fault maintenance process through touch screen operation

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Online learning levels the playing field; offerings taff at grassroots stations the same access to high-quality resources as their counterparts in provincial and urban centers. For instance, a staff member from a county station in Jiangxi Province leveraged ground observation resources from the meteorological distance education network for intensive study and revisions, ultimately securing the first prize in a provincial meteorological observation competition. Similarly, the 2023 National Weather Forecast Vocational Skills competition was won by a regional weather station staff member from Henan Province, who attested to the platform's rich content being particularly beneficial for grassroots personnel who have fewer opportunities for in person training. She appreciated the expert-led courses for their clarity and accessibility [10].

Each training course on the remote learning platform includes a discussion area, fostering a social network for learning where students can exchange ideas, share experiences, and thereby enhance their motivation and effectiveness in learning.

2.2. Network Synchronous Live Broadcast Training

Synchronous live broadcast is typically scheduled during work hours; these courses are often attended by employees from their offices. However, recent years have witnessed an increasing trend in mobile device usage for learning. For instance, the "Meteorological Knowledge Popularization Class", aimed primarily at liberal arts graduates, has seen a year-over-year rise in mobile learning participation from 2020 to 2022, as detailed in Table 1. Similarly, the "Basic

Atmospheric Science Knowledge Class", which caters to a science-oriented audience, also reflects an upward trend in mobile learning engagement from 2020 to 2023, as shown in Table 2.

Table 1: The class of "Meteorological Knowledge Popularization Class" conducted live lectures 4 times in 2020, 11 times in 2021, and 9 times in 2022. The mobile phone listening rate was 15.6%, 19.8%, and 36.1%

Year	2020	2021	2022
Sampling frequency	4	11	9
Study time	250	450	1115
Mobile learning time	39	89	402
Mobile learning (%)	15.6	19.8	36.1

Table 2: The class of "Basic Atmospheric Science Knowledge Class" conducted live lectures 5 times in 2020, 22 times in 2021, 11 times in 2022, and 15 times in 2023. The mobile phone listening rate was 17.3%, 28.1%, 28.2%, and 37.2%

Year	2020	2021	2022	2023
Sampling frequency	5	22	11	15
Study time	584	2539	1048	3346
Mobile learning time	101	714	296	1244
Mobile learning (%)	17.3	28.1	28.2	37.2

The prevalence of mobile learning also correlates with the professional duties of the learners. Consider the "2022 Weather Service Training Course for Agriculture", which primarily targets meteorological service providers in the agricultural sector who typically spend limited time in the office. Figure 3 illustrates that the adoption of mobile devices for learning in this course is notably high. This course exemplifies instances where mobile learning surpasses traditional desktop learning during live sessions on weekdays.

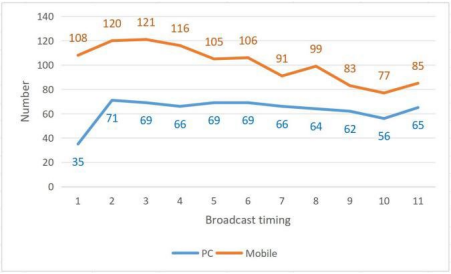

Figure 3: The figure is the comparison of learning data between PC and mobile devices in "2022 Weather Service Training Course for Agriculture", the blue line is the PC device, and the orange line is the mobile device

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Despite being hosted in the cloud, live training sessions resemble traditional in-person training in nature, employees are encouraged to engage in these sessions during off-duty hours, and they are permitted to use office computers for studying while at work. Nevertheless, there is a noticeable annual increase in learners using mobile devices.

Moreover, not only can learners access content via mobile devices, but instructors can also conduct lessons from mobile platforms (as depicted in Figure 4) [11]. This approach to on-site teaching via mobile enhances the overall learning experience for students.

Figure 4: Mobile teaching: On-site teaching of the layout and use of portable weather stations in vegetable greenhouses

As technology advances and facilities improve, in settings such as on-site conferences or large classrooms, attendees tend to focus more on the teacher's live image projected on a large screen rather than the teacher physically present on the platform, who may not be as clearly visible. In this context, even if the teacher is in a different location, as long as there is seamless communication and interaction without network delays, the effectiveness of the session remains comparable whether it's conducted in person or virtually in the cloud [12].

2.3. Construction of Meteorological Mobile Learning Resources

The rise of mobile learning has been remarkable, driven largely by its capacity to enhance participation and enrich learning experiences in both formal and informal settings [6]. The proliferation of mobile learning hinges on the availability of high-quality resources.

The effectiveness of learning content is crucial, but the format of the course also plays a significant role. Currently, the prevalent micro-video format prioritizes knowledge delivery while integrating audio, imagery, and text. Moreover, considering the portability, smaller screens, and limited viewing duration appropriate for mobile devices, as well as battery life constraints, course designs should be succinct and compact [13].

Course content and form. Mobile learning resource development is centered on student needs, with short, knowledge-based videos proving particularly effective for mobile learning. These videos, typically under 10 minutes, are designed to be concise with clear objectives and focused themes, addressing practical problems. Engaging and dynamic production further enhances their appeal. Notably, courses featuring recorded on-site operations (as shown in Figure 5) have gained significant popularity. These allow students to simultaneously observe the instructor's demonstrations and apply the lessons to real world maintenance and troubleshooting of malfunctioning instruments.

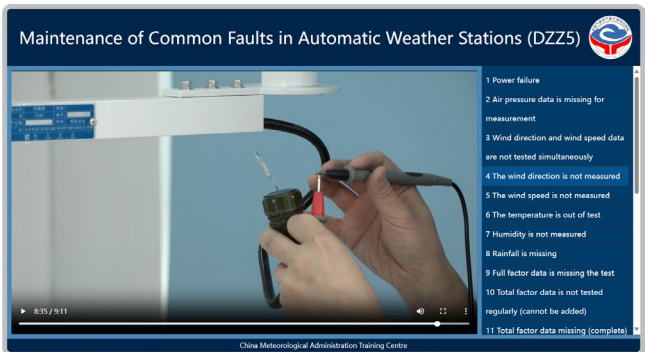

Figure 5: Live demonstration operation for troubleshooting wind direction sensor

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Video course size and resolution. To optimize the effectiveness of mobile learning, seamless video playback is crucial. Video lag or slow loading can induce learner anxiety and negatively impact the learning experience. Typically, video settings are determined by dividing the available export bandwidth by the estimated simultaneous student count. The current standard for bitrate is under 400kbps, with a video frame rate of 25 frames per second and a frame width of 1920. Testing has shown that these parameters enable both computer and mobile playback to meet current educational standards. As device performance improves, these parameters can be further refined in post-production to enhance quality.

In addition to resolution, video size is influenced by the richness of the picture's color and the variance between frames. For example, analyzing videos with bitrates ranging from 180 to 350kbps and a resolution of 1920x1080 (as outlined in Table 3), we find that the size per second varies between 0.03M and 0.11M. This suggests that a 5-minute video of similar bitrate and resolution might range from approximately 9M to 33M in size, while a 2-hour (90-minute) course could be between 160M and 600M, and the size could reach around 6G for a comprehensive 20- hour module. For learners engaged in long-term studies, mobile data usage thus becomes a significant factor in mobile learning.

Table 3: The table indicates the estimation of the corresponding traffic volume occupied by video courseware of different time lengths

Video duration (min, s)	3'44"	26'38"	18'08"	34'24"	5'18"	11'25"	30'17"
Video Size (M)	6.69	60.4	40.2	121	10	75.9	90.9
Verage video size per second (M/S)	0.03	0.04	0.04	0.06	0.03	0.11	0.05

2.4. Outlook of Meteorological Mobile Learning

The meteorological remote learning and mobile learning platforms primarily cater to employees of meteorological departments. As discussed earlier, there has been a quiet yet notable increase in learning via mobile browsers. The official launch of the mobile learning platform allows for a more comprehensive understanding of mobile learning trends.

The global workforce is currently undergoing a significant transition, with individuals born in the 1960s and 1970s either retiring or advancing into the latter stages of their careers. Simultaneously, Millennial (born between 1983 and 2000) and Generation Z (born between 1996 and 2010) are entering the workforce. These newer generations are characterized by a 'mobile-first' approach and display a greater openness to learning through personal devices.

As observed, the demand for mobile learning is evident among Millennial, and it is anticipated that Gen Z will further solidify mobile learning as a norm across various organizations [14].

Since 2010, the meteorological department has been undergoing a generational shift, annually recruiting numerous high-caliber young professionals predominantly from the Millennial and Gen Z cohorts. These individuals are not only adapting to new learning methodologies but are also the primary audience for mobile learning. Their preferences and practices are poised to significantly influence the future direction of meteorological training.

3. Current Challenges and Development Proposals

At present, in the meteorological department, because all departments will participate in the management and service, the offline training is charged, which is related to the survival of the training unit and the income of employees. However, online training has been maintained for public welfare and free since it was launched in 2005. Enter the digital age; because most of the online training can meet the training needs, offline t raining has been greatly affected, just like the relationship between many offline physical stores and online stores. For the survival and development of the unit, the management department needs to support face-to-face training, so network training will not be taken seriously. Therefore, in recent years, the development of network training and mobile training in meteorological departments is lagging behind the society.

However, we should clearly realize that technological development is irreversible and conform to the general trend; only the accommodator can be survival. People are gradually adapting to mobile learning, and then we can find a breakthrough in the development of mobile learning. The planning and development of mobile learning resources also need to invest in human and material costs, so the most

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of people should understand if mobile learning starts charging. Then, because of the huge quantity of network mobile learning, the percapita fee will be far lower than offline training, which is a win-win situation for training units and trainees. In addition, some practical training courses or seminar courses, which require teachers to view and tutor in real time, can continue offline training, while other types of courses are gradually transferred to online training. The combination of online and offline training can also promote the common development of various training methods.

4. Conclusion

Digital mobile learning offers a modern alternative to conventional education and training methods. It provides learners with a convenient and highly accessible means of engaging in educational activities, effectively removing geographical barriers and incorporating interactive elements regardless of location [15]. Whether people like it or not, the rapid adoption of mobile devices is a global trend that has taken over the way people learn and consume, and necessary for training or sharing knowledge. If learning is only dependent on the desktop, a lot of learning will not continue [1].

In the context of the digital era, we are witnessing an unprecedented surge in the availability of information and emergence of new knowledge. In such a fast-paced environment, individuals frequently encounter pressing issues in their work and studies, making it challenging to stay abreast of all pertinent information. Mobile learning offers a solution, enabling on-the-go search and query capabilities. It allows for a practical, learn-while-doing approach, a feat traditional training systems struggle to achieve promptly. In a world increasingly geared towards lifelong learning, the need to memorize vast amounts of information is diminishing. Instead, people can rely on portable mobile devices to access cloud-based resources anytime, anywhere. Future training and learning modalities are expected to evolve in response to these changing lifestyle patterns. Thus, with continued technological and digital advancements, mobile learning is poised to significantly transform and benefit the field of training [16].

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