Facilitating Learning Interests Through Mobile Information Visualization

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Abstract—In this paper, a mobile approach for ambient learning is presented. As an example of the concept, modeling is done to deliver educational content on weather phenomenon to schoolchildren. Information visualization techniques are utilized to present an alternative approach of knowledge delivery that could be considered to be beyond conventional classroom based teachings.

The concept is demonstrated with the ‘Interactive Weather Information System’ (IWIS) platform. During the user tests, the effectiveness of the proposed method on knowledge conveyance was evaluated. Usability tests showed that IWIS serves as a good stimulus to captivate the learning interests of the target user group (children from 10 to 12 years old). In addition, the new issues that surfaced could be used as design considerations or factors in subsequent research work in this area.

Keyword: information visualization, mobile learning, visual cognition

I. INTRODUCTION

The emergence of computing devices has fronted a revolution in broadening the scopes of teaching and learning. The concept of learning in the 21st century extends into our daily lives through multimedia, Internet-based as well as mobile modes of learning [10].

Mobile devices have been widespread worldwide in recent times. In Singapore alone, the mobile penetration rate reached 134% in June 2009 and this figure exceeded the two other dominant telecommunication services, the fixed-line telephone (96.6%) and broadband Internet (118.5%) [9]. This growth is currently in a sustained trend, lending mobile learning an edge to exhibit its advantages in areas of the academia as well as the industry. With consideration to the potential user group size, mobile learning may only become more popular in the near future despite the few key challenges [3].

The effective delivery of abstract information is an important but challenging task in the design of effective mobile learning environments. A good example is the presentation of weather information.

Weather information tends to be abstract and less interesting especially to children in primary schools. Its raw data can range from temperature, rainfall to more abstract forms such as air pressure and humidity that actually make better sense to those who are already familiar with the subject. More often, they could appear less apparent to children [1]. It is therefore not easy for children to comprehend the concepts without memorization of the texts, which would otherwise considerably reduce the ‘fun’ and interest in learning. Making use of information visualization facilitates the learning process by effectively reducing the associated complexities.

Information visualization of raw weather data helps to address this problem by attempting to hide the complexity of the original abstract information and then presenting it in a visual form that can be easily understood with people’s natural visual capabilities [4] so that it may help increase children’s learning interests. An example on the application of a information visualization technique was discussed in [6], where authors proposed a method of visualizing weather information using textured patterns. This method could be effective for weather surveyors and professionals but it would however, still be overly complicated for children.

This paper proposes a mobile learning tool that aims to deliver the chosen abstract educational content more
easily with the help of visually appealing icons and graphics as the key stimuli. The system implementation “Interactive Weather Information System” (IWIS) presents weather information in an engaging and fun form using rich visual metaphors. IWIS is developed for both the Google Android as well as the Apple iPhone (as variant versions). It aims to motivate the target user group (primary 4 to 6 students) to learn about weather information in an enticing approach by being graphically appealing.

II. MOBILE LEARNING ON WEATHER

A. Motivation

Mobile devices today are often equipped with assistive capabilities including Internet content browsing, the sending and receiving of emails, music playback and gaming support, providing users with location-based tracking (GPS) and supporting personal information management to serve the role of a digital personal assistant. Intelligent mobile devices have increasingly gained popularity and dominance as the market emphasizes on the shift towards ubiquitous and mobile computing [7].

Advancements in mobile technologies can present positive opportunities for educational content to embrace such platforms and these may reformulate the traditional concepts of education by pushing the mode of teaching and learning into a new era of mobile learning (or m-learning) [2][5], where learning is no longer physically constrained by the classroom environment but able to occur anywhere instead [10].

On the other hand, as certain specific weather trends in Singapore do not vary significantly or generally have low fluctuations through the year, young children lacking exposures in overseas travel may find it difficult to establish a good sense of awareness of other possible weather conditions in contrast, and this may result in the lack of motivation (in some) in wanting to learn and acquire such knowledge at the first opportunity. In addition, because of the abstract nature in the subject of weather and its ambient information types, children may be deterred from exploring the knowledge domain of weather. There is therefore a need to convey this knowledge to them in an alternative and meaningful approach, starting with the local weather context. This fundamentally formed the motivation for our work.

It is hence established that the concept of using mobile learning of weather information would use enticing information visualization methods. Using this approach, it was observed that young children would be more responsive and attentive to the colorfully designed and enriched visual content. Various specially designed graphical elements were used to represent weather information so that it would as much as possible reduce the inherent complexities associated with its corresponding raw data. Taking advantage of the ubiquitous nature of mobile devices, the proposed system can potentially stimulate the learning interests of children on various weather components and enable them to appreciate the expansive learning environment brought forth by mobile technologies.

B. Design Consideration

In [8], authors presented several guidelines on the interface design for mobile learning applications in the pedagogical domain. In summary, the interface design should ensure accessibility, intuitiveness and simplicity with the content being independent of the interaction mode(s). Further, any multimedia objects used to present information should be appropriately designed and should be derived from the specific usage context. Adhering to these, IWIS is designed to employ 2D graphical elements that respectively reflect the various weather components (ambient temperature, humidity, rain fall, wind speed, wind direction and air pressure). The information is retrieved in either real-time or as post-dated data (depending on stations’ operation status) from the mini weather stations that were previously deployed in schools around the main island of Singapore as part of the National Weather Study Project.

As an example, (Fig. 1) shows the weather data of a station located in Saint Nicholas Girl’s School. Data obtained from the station included the selected six weather information types in alphanumeric format.

In IWIS, the user interface (UI) is constructed using a visual style with the intended goal that it would appeal reasonably well to the target user group and enhance the general understanding of the overall usage flow. Components are also intuitively designed such that the number of inputs required from the user is kept minimal and easily comprehended.

As a “location aware” application, IWIS offers two modes of location tracking, GSM for indoors and GPS for outdoor environments (Fig. 2).
The next input from the user is to pinpoint a particular mini weather station of interest. This interaction is performed via Google Map’s interface (on the mobile device) by navigating around the local map to select a station (Fig. 3).

C. Learning through Information Visualization

1) Learning elements: In [12], learning context is defined to exist in various dimensions. In the learner’s dimension, the “focus of attention” appears to be an important part of intrinsic and psychological properties that determine the success of learning. Adopting this principle, information visualization is utilized in the attempt to attract and retain attention from schoolchildren and using this bond of attraction to stimulate their learning interest on the subject of weather.

2) Similar work: Various existing systems (Fig. 4) attempted to address the issue of weather data visualization. One common similarity in them is that they tend to use numerical raw data directly as the main form of visualized representation. Hence, the conveyance in such form could be less effective to children.

3) Visualization with visual metaphors: [11] shows how visual metaphors were applied to assist teaching abstract concepts and to help learners visualize the subject content. With the primary objective of ‘stimulating learning interest’, a similar methodology is followed in the system design of IWIS.

Instead of presenting raw weather data in plain numeric forms (Fig. 4), it is instead mainly represented with visual metaphors. In (Fig. 5, left), unique graphical elements are used to symbolize the six selected weather data types (symbolic shapes of the Sun, Water Droplet and Circular Bar Segments etc). All these elements are drawn inside a circular wheel for optimal space utilization in the resolution-constrained mobile screen. Elements on the graphical scale are rendered into the screen according to the actual numeric weather data received at each mini weather station with the station’s name displayed at the bottom.

Visualizing the complete set of selected information in limited screen space is a practical approach to achieve the objective of “information at a glance”. However, if users are to have queries on any one particular aspect of the presented weather information or are interested to find out the actual numerical data value, they may choose to focus on it by pressing the corresponding icon from the row at the top of the circular wheel (Fig. 5, right). The numerical value of the actual data will appear at the center of the disc and
the respective symbolic form representing this information is highlighted with the remaining background grayed out. At the same time, accompanying text is shown in the dialogue box at the bottom to inform a descriptive explanation of the selected phenomenon and how it is commonly measured (in SI unit).

By design, embedded educational content is communicated to the target users on mobile devices; this particular approach of knowledge delivery thereby may be equal (if not more effective) than traditional classroom-teaching environments. To assess accessibility and usability, conducted tests were conducted with IWIS (Google Android version) and the responses from users were studied. This was done with the intent of not only to gather feedback on the existing system for learning but also to evaluate issues that had not been addressed or omitted. Such investigations would serve as useful references for the future development of IWIS.

III. USER FEEDBACK

A. Usability Testing

A task-based usability test was conducted with 6 participants drawn from our target user group. They were 12 years old male students from a local school in Singapore and an average of 40 minutes was spent with each of them. The test consisted of 6 tasks to be completed as well as a questionnaire at the end of the session to collectively assess the system’s usability as well as to gather feedback on the overall effectiveness to facilitate learning.

B. System Evaluation

1) Positive impressions: The colorful and vibrant UI assembled from various pieces of matching graphics appealed most to users. All participants had good impressions on the visuals presented throughout the testing and they were intrigued to explore the application despite having difficulty on system navigation flow and information recognition. Such feedback attributed that the usage of appropriate graphical elements would be a valuable approach to garner children’s attention and focus.

Children’s understanding in the knowledge content was queried through an interview where they were specifically asked to briefly explain what they thought a particular visual element on the screen was trying to teach or convey them. Majority of the students were able to understand the intended meanings of the weather knowledge and correctly associated the identified visual element to its corresponding weather type.

Moreover, it was observed that there was anticipation in users to desire to know and see more information in the application. Such behavior positively demonstrated the achievement of the primary objective of using IWIS as a tool to stimulate learning interest on the subject of weather.

2) Unveiled issues: Through the test we have also unveiled issues that may be used as reference for future research. Firstly, the downside of having to visualize all the information types within a limited space is that the icon and figures would be small in display size and thus difficult to be pressed accurately (for touch-based interfaces). In addition, information presented in a singular collective mode may cause confusion to users especially where a user’s guide is not readily available. This can generate uncomfortable interaction experience(s). Secondly, information can be rearranged to lessen the required effort that the user would have to spend to explore and understand it. The current system can cause readability issues. Some users may need to physically rotate the phone in order to read certain information displayed on the circularly designed ‘disc’ graphic layout. Moreover, when a selected information type is being highlighted, first-time users can be confused as to which part of the visual presentation to immediately focus on. With the guidance of displayed arrow signs, although users would generally be able to quickly identify the appropriate element of focus, some may overlook the actual numeric data shown at the center of the ‘disc’.

Other user-suggested feedback received is divided into 3 parts; the first part is to include a tutorial (within the application) to reduce the user’s learning effort, particularly for first-time users. Secondly, users proposed that extended educational weather components such as acid rain could be included to strive towards better learning goals. Lastly, users need more instructional guidance to be presented from time to time when they appear to be stuck. Extra assistance could be built to facilitate and improve the system’s navigational flows.

IV. CONCLUSION

We presented a case where IWIS is used as a mobile learning tool to communicate educational content to the target user group, children from 10 to 12 years old. The motivation originated from the foreseeable widespread penetration of mobile technology and the attempt to deliver knowledge beyond traditional classroom context. The primary objective is to stimulate children’s learning on abstract weather knowledge by reducing the associated complexities during the process. Usability tests showed that IWIS effectively delivered knowledge to users and raised their interest in ambient learning. Other issues that resulted from the tests included information arrangements and user interactions. Further research can be carried out based on these issues to uncover more on children’s computer interface behavior and possibly to establish a mobile design framework for similar learning systems in future.
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