An Interactive Recommender System for Group Holiday Decision-Making

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Abstract. Various types of applications are available on mobile devices that support the holiday decision-making of individual tourists. However, people often travel in groups and existing applications lack the services to support the decision-making of tourists who travel in a group. In group holiday decision-making, intra-group interaction plays a major role. In this work, we design an system that provides recommendations for tourist groups based on their travel preferecnes. Meanwhile, the system allows each group member to participate in the process of such recommendation through the design of interactive features. The recommendation mechanism is based on an ontology that describes the tourism-related information of a destination. This paper presents the design idea, the development of the system (including the ontology, the aggregation strategy, the recommendation mechanism, and the interactive features), and the preliminary findings of evaluating the user experience. The results show that the system facilitates the group holiday decision-making and provides users with an engaging experience.

Keywords: User interface · Holiday decision-making · Tourist group
Recommender system · Ontology · Mobile devices · EEG

1 Introduction

Holidays have played major roles in people's lives, providing opportunities for them to experience something that are different from their everyday routines [1]. The process of holiday decision-making is considered an important part of the whole travel experience. In many cases, people tend to travel with a group of people, so that they may socialise, enjoy the company of each other, and better fit into their communities [2]. Therefore, the process of group holiday decision-making has drawn attention by many researchers and the characteristics of intra-group interactions among group members are examined, such as group cohesiveness and congruence [2]. With the development of Web 1.0, Web 2.0 and social media, tourists, especially those who travel in groups, now rely more on the Internet to obtain tourism information and share information among themselves, and to make decisions. Online tourism domains are examined and categories are put forward, such as review websites, virtual communities, blogs, etc. [4]. Existing travel planning applications and designs have explored some functions for tourist groups, where group members can work on their itineraries together and acquire personalised services, such as Tripomatic (tripomatic.com). However, the designs of

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interactivities to support understandings among group members in the decision-making process have not been examined adequately, especially in personalisation applications. This paper aims to explore how group recommendation with interactive features can facilitate the group holiday decision-making experience.

We focus on the two main characteristics that are essential in this design: making recommendations for tourist groups and allowing group members to participate in the recommendation process. Firstly, existing studies have proposed different types of mobile-based recommender systems in the field of tourism [3, 5]. Among those recommendation mechanisms, ontology-based mechanism is the most efficient and accurate, that it represents the domain knowledge and later is to be used in recommendation processes [6]. In the recommendation for a group of users, studies have explored ontology-based mechanisms in various fields, such as tourism and movie [7]. The underlying mechanism of this system is adapted from Garcia et al.'s work [8]. They propose a recommender system for tourist groups based on an ontology of tourism information of a certain destination. Secondly, understanding each other's opinions among group members is essential in group work [9]. Interactive features are found to have positive effects on user experience in the studies of human-computer interaction for entertainment, such as interactive music sharing [10]. However, very few have the interactive features that involve the users in the recommendation process. This system aims to make use of the recommendation mechanism, allow group members to participate in the recommendation process, and further support a better understanding of each other's travel preferences and opinions.

We further develop a prototype of the interactive group recommender system that provides tourist groups with tourism recommendations based on users' preferences and their interactions with this system. To evaluate the system, both subjective approach (questionnaire surveys and interviews) and objective approach (electroencephalography) are employed to examine the usability of the system, the degree of engagement when interacting with the system, and the performance of the interactive features.

2 Literature Review

2.1 Ontology-Based Recommendation Mechanism

Ontology-based recommender systems are examples of how semantic technologies may be integrated with Web services to leverage each other's strengths. Existing studies have explored how ontology-based recommender mechanisms can facilitate the holiday decision-making process. For example, Wang et al. [11] propose an ontology-structured tourism recommender that allows the automatic and dynamic integration of heterogeneous online travel information. To realise personalisation for tourists, individual's travel preferences are also involved and considered in the ontology-based recommendation mechanism [7].

With regards to a group of users, existing studies have explored how to make recommendations for groups based on individual's travel preferences. One more step is added before the recommendation mechanism - aggregation of individual preferences to obtain a group preference. *e*-Tourism is designed by Garcia et al. [7, 8], that it aims at recommending a list of tourist activities for a group of tourists based on an ontology of the city of Valencia (Spain). Firstly, *e*-Tourism requires the tourists to build their user profile, enter their travel preferences and general likes. Secondly, group preference is generated through aggregating the individual preferences. Lastly, group recommendation is calculated based on the group preference. The mechanism of the system in this paper is built on Garcia et al.'s work with a newly designed aggregation strategy that allows users to participate in the group recommendation process and interact with the system.

2.2 Interactive Features in Recommendation

Developing novel interactive features is an important research area in the studies of human-computer interaction, such as supporting for learning [14], enhancing newspaper reading experience [15], etc. In the context of group work, interactivity is a particular medium, which has the ability to facilitate two-way communication among the group members [16]. Such communication can be supported via direct dialogues, such as face-to-face, phone calls, and instant messaging applications (WhatsApp). It also can be supported indirectly through certain interactive features provided by technologies. For example, animated representatives of each group member is generated to enhance visualisation, mimic intra-group dialogues, and facilitate the communication experience [17].

With regards to the interactive features in personalised recommendation, a collaborative group recommendation has been developed that enables four users to simultaneously engage in parallel recommendations, in which personal and group profiles are exploited through the interactivities with the device [18]. In this paper, interactive features are designed for the purposes of: (1) making group members aware of each other's travel preferences, and (2) allowing group members to participate in the group recommendation process.

2.3 Evaluation Method

Evaluation of user experience is practised in various fields (e.g., gaming, website [19, 20]) using different methods. Subjective methods (e.g., questionnaire surveys [20]) are convenient, but they are inherently biased by the participants' personal feelings and opinions. Therefore, physiological metrics have also been employed, as objective methods, to simultaneously acquire physiological data, e.g., electroencephalography (EEG), skin conductance, etc. Existing studies have used physiological metrics to identify human emotions [20], psychological stress [22], and working memory load [21]. In this paper, both subjective methods (questionnaire surveys and interviews) and objective method (EEG) are used to investigate the usability of the system, the degree of engagement when interacting with the system, and the performance of the interactivities.

3 System Design and Development

3.1 Design Principles

The goal of this system design is to facilitate the holiday decision-making of tourist groups. Our system needs to meet two main design principles. First, it should be able to provide recommendations for a group of tourists based on their individual travel preferences. Second, it should allow users to participate in the recommendation process through the design of interactive features. An ontology-based recommendation mechanism was developed and the following sections introduce the ontology, the aggregation strategy, the recommendation mechanism, the interactive features, and the development of the system.

3.2 Ontology

This system aims to provide personalised tourism recommendations for tourist groups about Nanjing, China. The ontology of this system describes the tourism information of Nanjing, which is built based on the knowledge of ten senior travellers from Nanjing. The structure of the ontology is adapted from Garcia et al.'s [7, 8] work, while the building of the ontology is based on the guidance by Noy [22].

Firstly, nine ***classes*** are identified based on a tourism ontology developed in SigTur [23]. They distinguish the sightseeing attractions in Nanjing. Ten sightseeing attractions are chosen as ***instances*** (items) in the ontology. Secondly, ***relationship*** between classes and instances are built. It is a link to connect the classes to each instance and each instance can link to more than one class. The value of each relationship (d_{ij}) shows how much an instance represents a class (in a range from 0 to 100). Lastly, a ***score*** is assigned to describe the popularity of each instance (S_i). See Fig. 1 for parts of the ontology.

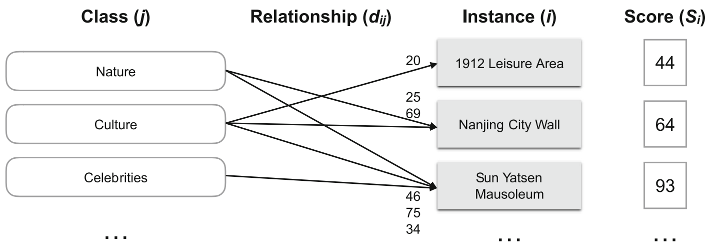

Fig. 1. Parts of the ontology used in this system.

3.3 Aggregating Group Profile

This system records a profile for each user that contains individual users' general tastes in terms of travel preferences. The individual profile of a user (IP^u) is represented by a list of tuples in the form $IP^u = \{(u, j, p^{uj})\}$, where $j \in Class$, and $p^{uj} \in [0, 100]$ is the degree of preferences given by the user u to a certain class j. In case of a group of users, all the individuals must be previously registered and have submitted their individual user profiles. This system will consider all the individual profiles in a group as whole to make group recommendations. And there is one step before making recommendations: obtaining group user profile.

To obtain group user profile of a tourist group, firstly, travel preferences of each group member is obtained explicitly from the users through a questionnaire; secondly, aggregation of the individual preferences is conducted to derive a group preference. This aggregating machenism is fed with individual profiles (IP^u) of all group members, and returns one aggregated group profile, $GP^G = (G, j, p^{Gj})$, where $j \in Class$, and $p^{Gj} \in [0, 100]$ is the degree of preference of group of user G to a certain class j.

While there are different types of aggregation strategy [13], one strategy was chosen in this system to support one of the interactive features. This aggregation strategy begins with a standard average calculation over the travel preferences of all the group members towards one class, in which each member has the equal influence on the group preference. Then the interactive features allow users to manually change the influences of any group member by modifying the weight, $W_u \in [0.5, 1.5]$, of any group member u in a tourist group. The range of the weights was from 50% to 150%, which means that the minimum influence of a group member can be set to 50% of its normal influence, and the maximum influence is 150%. Every time when the aggregation strategy is manually adjusted, the system will provide new recommendations for the tourist group.

GP^G is the result of aggregating all individual profiles in a tourist group. This system calculates the average values of the preference-degrees of n users in G for the class j, with a weight on each user u that is adjustable by any user. An example is shown in Table 1. More formally:

$$GP_j^G = \frac{\sum_{u=1}^{n} W_u p_{uj}}{n}, u = 1 \sim n, j = class\,1, class\,2, \ldots, class\,m \quad (1)$$

Table 1. Example of aggregating mechanism

	Class 1	Class 2	Class 3	Weight
Profile - user 1	10	94	55	100%
Profile - user 2	30	65	38	60%
Profile - user 3	40	45	91	140%
Group profile	(10 × 100% + 30 × 60% + 40 × 140%)/ 3 = 28	(94 × 100% + 65 ×60% + 45 × 140%)/ 3 = 65	(55 × 100% + 38 × 60% + 91 × 140%)/ 3 = 68	N/A

3.4 Recommendation Mechanism

The model of calculating of recommendations is in charge of selecting the items (*instances* in ontology) that satisfy the group's preferences, based on group profile GP^G and the ontology introduced previously. This recommendation mechanism produces a list of recommended items, RI^G. It is a set of tuples of the form $RI^G = \{(i, D^{Gi})\}$, where i is the recommended item, and D^{Gi} is the estimated degree of interest of a group G in the item i. The degree of interest (D^{Gi}) of the group G in an item i is calculated as follows:

$$\begin{cases} D^{Gi} = per(S_i) \times \sum_{\forall (j, p_{Gj}) \in GP^G} \left(d_{ij} \times per\left(p_{Gj}\right)\right), \\ per\left(p_{Gj}\right) = \frac{p_{Gj}}{max(GP^G)}, \\ per(S_i) = \frac{S_i}{max(S)}, \\ i = item\, 1, 2, \ldots, k;\ j = class\, 1, 2, \ldots m \end{cases} \tag{2}$$

The recommendation mechanism then rearranges the order of the items (*instances*) in descending order based on the degree of interest assigned to each item (D^{Gi}). The final recommendation will display the top 7 items for the tourist group G. In their work, degree of interest, D^{Gi}, calculates the sum of the three entries, $per(S_i)$, d_{ij}, and $per\left(p_{Gj}\right)$. We calculate D^{Gi} using the multiplication to better describe the degree of interest towards each instance (first equation in Eq. 2).

3.5 Interactive Features

Two interactive features are designed in this system. First, as introduced in the aggregation strategy, users can participate in the recommendation process by manually adjusting the influence of each group member. So users can repeatedly check the recommendation results with different inputs (group member's influence – Fig. 2 left).

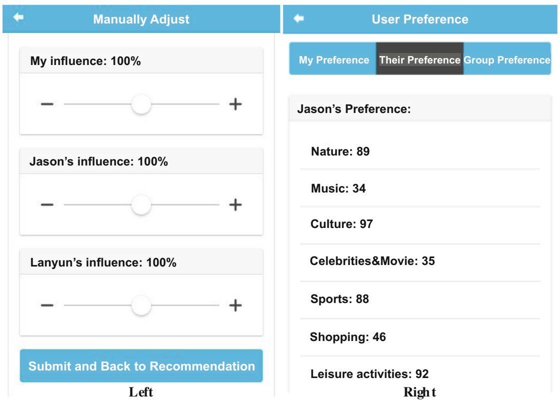

Fig. 2. Screenshots of the interactive features.

Second, this system allows users to check the travel preferences of all the individual group members and the travel preferences of their group as a whole (Fig. 2 right). This feature enables the users to be aware of each other's travel preferences, so that a holiday decision is made to have the maximum satisfaction.

3.6 Development of This System

The development environment used to build this system is appery.io, which is a rapid development, integration and deployment platform for delivering cross-device applications. It provides browser-based development environment; integrates the interface and backend services; enables rapid creation of a mobile application for immediate evaluation.

This system requires the establishment of communication between the mobile interface (graphic user interface), a web server, and a database. To understand the entire architecture, Fig. 3 shows the components and their functions in the building of this system.

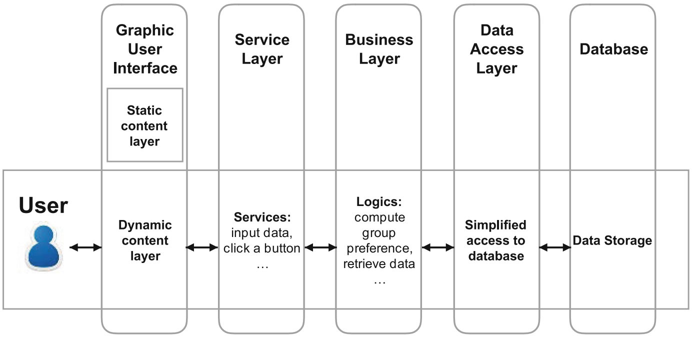

Fig. 3. Architecture diagram of this system.

4 User Study

4.1 Aim and Experiment Design

The aims of this user study were to evaluate the usability of the system, the degree of engagement when interacting with the system, and the performance of the interactive features. A between-subject, scenario-based experiment was designed to compare the group trip planning experience with the assistant of two types of tools: this system vs. commonly used mobile applications for trip planning. These commonly used mobile applications were selected freely by participants, which include mafengwo, qiongyou, tripadvisor, C-trip, and baidu travel.

Firstly, usability was measured by Nielsen's 10 usability heuristics [23], in which 4 question items were omitted as they were not applicable to this system evaluation. The measured 6 question items are listed in the result (Table 2). Secondly, the level of engagement when interacting with a piece of technology (this system and the commonly used mobile applications) was measured via a commercial EEG device - NeuroSky Mindwave headset. This device has been used in the evaluation of user experience [12]. Lastly, the performance of the interactive features was evaluated through face-to-face interviews of participants.

Table 2. Median values of usability heuristics.

Usability heuristics	Other apps	This system
1. Simple and natural dialogue	6.5	6
2. Speak user's language	6	6.5
3. Minimise user's memory load	6	6
4. Consistency	6.5	6
5. Clearly marked exits	6	6
6. Shortcuts	6	5.5

4.2 Participants

18 groups of participants were recruited from the University of Nottingham, Ningbo, China. Within each group, there were three members (apart from one group that was a couple), and in total there were 53 participants (31 females, 22 males). All of the participants were Chinese. The requirements of recruiting the participants were: (1) they had prior group trip planning experience with mobile applications, and (2) at least one of the group member in each group had not been to Nanjing. To compare the user experience with and without the assistant of this system, 9 groups of participants were asked to make a group trip plan to Nanjing using this system, while another 9 groups to make such trip plan using their commonly used applications. Participants were compensated for their time.

4.3 Procedure and Task

After the participants had signed off the consent forms, they were given an instruction of the task and the scenario: "*The three of you are planning a two-day trip to Nanjing as a group. You can use this system (for 9 groups)/any mobile applications that you are familiar with (for another 9 groups) to help you. The task is for you to think about what you want to do in Nanjing. The only requirement is that the three of you cannot have verbal communication in this part. You will need to produce a trip plan by the end of this task.*" During the period of performing the task, two participants in each group were required to wear EEG headsets (due to the limitation of the devices). After the tasks were completed, participants in the groups using this system needed to fill out a questionnaire survey regarding usability (7-point Likert questions). Lastly, follow-up interviews were given to obtain participants' opinions towards the performance of the interactive features.

4.4 Data Analysis

The questionnaire in this study aimed to measure the usability of using this system. Frequency and descriptive statistics were employed to gain an overall understanding of the opinions of the participants. Data collected from EEG devices was ranged from 0 to 100, which represented the attention level of interacing with the system. Independent *t*-test was used to compare the attention level between two groups of participant (i.e., one group using this system vs. one group using other commonly used mobile applications). The performance of the interactive feature was evaluated through face-to-face interviews. Interview data was qualitative in nature. The Emergent Themes Analysis [26] was conducted to understand the data.

4.5 Results

Usability. The 53 datasets of the usability questions (7-point Likert questions) were not normal distributed, so median values were analysed and Mann-Whitney tests were used for statistical analysis. The outcomes show that the median values of the 6 usability items were no smaller than 5.5 (Table 2), which indicate that the participants had positive views regarding the usability of this system. Across the 6 items, Mann-Whitney tests show that there are no significant differences between the usability of other commonly used mobile applications and this system ($p > 0.05$). This finding indicates that this system performed quite well in terms of usability, which is found to be as well as the commonly used mobile applications for travel and holiday planning.

Degree of Engagement. The brainwave data derived from the NeuroSky headset included an attention indicator to indicate the mental focus and the degree of engagement of participants. The values of the attention indicator ranged from 0 to 100. Over the 18 groups of participants, independent *t*-test shows significant difference in participants' attention level ($p < 0.001$) that participants using this system (M = 57.58, SD = 17.19) were more focused and engaged in the group trip planning task compared with participants using their commonly used mobile applications (M = 56.31, SD = 16.13).

Interactivity Performance. First, this system allows users to participate in the recommendation process by manually adjusting the influence of each group member. This interactive feature has been used in different ways and received positive feedbacks from the participants. For example, one participant said: "*Since I had been to Nanjing before, and the other two had not. So I wanted to know what they might like to do. Then I just reduced my influence in the group to the minimum, and maximised their influences. I quickly got the recommendations for them and then made decisions. It helped a lot.*" Second, this system allows users to check the travel preferences of all the group members. This interactive feature has also obtained positive comments, "*I had a look at the preferences of the other two people and quickly knew what they generally liked in travelling, so I immediately had an idea of where we might go in Nanjing. It is really helpful.*"

5 Discussion and Conclusion

How to better facilitate the experience of group holiday decision-making through technology? Based on the findings from existing studies, it is essential for a group of tourists to reach a congruence through intra-group interactions [2]. From this perspective, we design and evaluate an system that provides recommendations for tourist groups and supports group members to participate in the process of the group recommendation. The empirical results demonstrate that, first, the functions and interactivities in this system are able to support usability.

Second, the 'attention level' derived from EEG headsets shows significant increase when using this system to make a group trip plan. This finding might be confusing if relating 'attention level' to 'cognitive load'. Attention is the behavioural and cognitive process of selectively concentrating on a discrete aspect of information, and ignoring other perceivable information [24]. 'Cognitive load' refers to the total amount of mental effort being used in the working memory [25]. In other words, a high level of cognitive load can be caused by multiple tasks processed in a person's brain, while a high level of attention represents that the person can focus on one thing and ignore the distractions. This finding indicates that this system can increase the user's degree of engagement during the holiday decision-making.

At last, the interactive features of this system have received positive feedbacks from participants, that they are able to support the understandings among group members and positively assist the group trip planning experience.

We plan to further explore this issue through extending this system from two aspects. On the one hand, different aggregation strategies [13] in the group recommendation mechanism are worth exploring for different types of tourist groups. On the other hand, novel interactive features should be designed to facilitate the intra-group interactions during the group trip planning process.

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References

1. Decrop, A., Snelders, D.: Planning the summer vacation: an adaptable process. Ann. Tour. Res. **31**(4), 1008–1030 (2004)
2. Decrop, A.: Group processes in vacation decision-making. J. Travel Tour. Market. **18**(3), 23–36 (2005)
3. Braunhofer, M., Elahi, M., Ricci, F., Schievenin, T.: Context-aware points of interest suggestion with dynamic weather data management. In: Xiang, Z., Tussyadiah, I. (eds.) Information and Communication Technologies in Tourism 2014, pp. 87–100. Springer, Cham (2013). https://doi.org/10.1007/978-3-319-03973-2_7
4. Xiang, Z., Gretzel, U.: Role of social media in online travel information search. Tour. Manag. **31**(2), 179–188 (2010)

5. Borràs, J., Valls, A., Moreno, A., Isern, D.: Ontology-based management of uncertain preferences in user profiles. In: Greco, S., Bouchon-Meunier, B., Coletti, G., Fedrizzi, M., Matarazzo, B., Yager, Ronald R. (eds.) IPMU 2012. CCIS, vol. 298, pp. 127–136. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-31715-6_15
6. Borràs, J., Moreno, A., Valls, A.: Intelligent tourism recommender systems: a survey. Expert Syst. Appl. **41**(16), 7370–7389 (2014)
7. Garcia, I., Sebastia, L., Onaindia, E.: On the design of individual and group recommender systems for tourism. Expert Syst. Appl. **38**(6), 7683–7692 (2011)
8. Garcia, I., Pajares, S., Sebastia, L., Onaindia, E.: Preference elicitation techniques for group recommender systems. Inf. Sci. **189**, 155–175 (2002)
9. Forsyth, D.R.: Group Dynamics. Cengage Learning, Boston (2009)
10. Wu, M.: Interactive music playlist sharing system and methods. U.S. Patent Application 11/321, 571 (2005)
11. Wang, W., Zeng, G., Tang, D.: Bayesian intelligent semantic mashup for tourism. Concurr. Comput. Pract. Exp. **23**, 850–862 (2011)
12. Sourina, O., Liu, Y.: A fractal-based algorithm of emotion recognition from EEG using Arousal-Valence model. In: Biosignals, pp. 209–214 (2011)
13. Masthoff, J.: Group modeling: selecting a sequence of television items to suit a group of viewers. User Model User Adap Inter. **14**(37), 37–85 (2004)
14. Kennewell, S., Beauchamp, G.: The features of interactive whiteboards and their influence on learning. Learn. Media Technol. **32**(3), 227–241 (2007)
15. Chung, D.S., Yoo, C.Y.: Audience motivations for using interactive features: distinguishing use of different types of interactivity on an online newspaper. Mass Commun. Soc. **11**(4), 375–397 (2008)
16. Torres, F.A.: Towards a Universal Theory of Media Interactivity: Developing Proper Context. California State University, Fullerton (1996)
17. Jameson, A.: More than the sum of its members: challenges for group recommender systems. In: Proceedings of the Working Conference on Advanced Visual Interfaces, pp. 48–54. ACM (2004)
18. McCarthy, K., Salamó, M., Coyle, L., McGinty, L., Smyth, B., Nixon, P.: Cats: a synchronous approach to collaborative group recommendation. In: Florida Artificial Intelligence Research Society Conference (FLAIRS), pp. 86–91 (2006)
19. Takatalo, J., Hakkinen, J., Kaistinen, J., Nyman, G.: Measuring user experience in digital gaming: theoretical and methodological issues. In: Proceedings of SPIE (2007)
20. Siegfried, B.: Enhanced student technology support with cross-platform mobile apps. In: SIGUCCS: User Services Conference (2011)
21. Grimes, D., Tan, D.S., Hudson, S.E., Shenoy, P., Rao, R.: Feasibility and pragmatics of classifying working memory load with an electroencephalograph. In: Proceeding of CHI 2008, pp. 835–844. ACM Press (2008)
22. Noy, N.F., McGuinness, D.L.: Ontology development 101: a guide to creating your first ontology (2001)
23. Nielsen, J.: Usability inspection methods. In: Conference Companion on Human Factors in Computing Systems, pp. 413–414. ACM (1994)
24. Anderson, J.R.: Cognitive Psychology and Its Implications. Macmillan, New York (2005)
25. Sweller, J.: Cognitive load during problem solving: Effects on learning. Cogn. Sci. **12**(2), 257–285 (1988)
26. Wong, B.W., Blandford, A.E.: Analysing ambulance dispatcher decision making: trialing emergent themes analysis. In: Proceedings of the Human Factors Conference: Design for the Whole Person: Integrating Physical, Cognitive and Social Aspects. Ergonomics Society of Australia (2002)