Peer-reviewed version available at ISPRS Int. J. Geo-Inf. 2018, 7, 185; doi:10.3390/ijgi7050185

Article

Allocation of Tutors and Study Centers in Distance Learning using Geospatial Technologies

Shahid Nawaz Khan[1], Kamran Mir [2], Ali Tahir [3*], Arshad Awan [4] , Zaib un Nisa [5] and Syeda Aareeba Gillani[6].

[1] Institute of Geographical Information Systems, National University of Sciences and Technology, Pakistan; snawaz.ms16igis@igis.nust.edu.pk
[2] Dept. of Computer Sciences, Allama Iqbal Open University, Pakistan; kamranmir@aiou.edu.pk
[3] Institute of Geographical Information Systems, National University of Sciences and Technology, Pakistan; ali.tahir@igis.nust.edu.pk
[4] Dept. of Computer Sciences, Allama Iqbal Open University, Pakistan; m99arshad@aiou.edu.pk
[5] Allama Iqbal Open University, Pakistan and National University of Sciences and technology, Pakistan; zaib.nisa@aiou.edu.pk
[6] PMAS Arid Agriculture University, Rawalpindi, Pakistan; syedaareebagillani@gmail.com
* Correspondence: ali.tahir@igis.nust.edu.pk; Tel.: +92-51-9085-4476

Abstract: Allama Iqbal Open University (AIOU) is the largest distance learning institute of Pakistan and providing education to 1.4 million students. This is fairly a large setup across the country where students are geographically distributed. Currently the system works on a manual approach which is not efficient. Allocation of tutors and study centers to students plays a key role in distance learning for a better learning environment. Assigning tutors and study centers to distance learning students is a challenging task when there is huge geographical spread. The utilization of geospatial technologies in open and distance learning can fix allocation problems. This research analyzes the real data of twin cities Islamabad and Rawalpindi. The results show that the geospatial technologies can be used for efficient and proper resource utilization and allocation, which in turn can save the time and money. The overall idea fits into improved distance learning framework and related analytics.

Keywords: Geospatial Technologies, Distance Learning, Resource Allocation, AIOU

1. Introduction

Distance education is acquired by learner when the opportunity of face to face learning is limited or when there are not enough resources to cater the needs of such learning. There are educational disciplines where there may not be a need of lecture delivering and therefore several ways of communication are used by the educators and distance learners [1]. Many teaching strategies are employed by the distance educators to deliver the content to the distance learners in open and distance learning environment. The continuous growth of distance education has created new opportunities for distance learners and educators. Simultaneously, the continuous improvements for innovation in delivering techniques has also started. The educators have always focused on enhancing interactivity which is vital in open and distance learning. The proliferation of disruptive technologies has created an opportunity to achieve the maximum interaction which is evident from current trends of technology usage in distance learning [2].

Allama Iqbal Open University (AIOU)[1] is the largest distance education institute in Pakistan which provides distance education to the students in almost every field from higher secondary to doctorate level studies. The university admits candidates in different disciplines such as arts, management and science programs where each student is assigned a tutor who is responsible for marking the student assignments. A tutor is also responsible for formal meetings called workshops in study centers allocated to the students by the university. Currently, the university uses manual system for allocation of students and study centers. Until now, less consideration is given to exploiting locational intelligence of students and study centers. Due to lack of locational intelligence system, this creates many issues for distance learners when they are assigned study centers far away from their home addresses. This also reduces the socialization and interaction on the student's part.

The distance education is an emerging research and development area with the integration of multi-disciplinary approaches and proliferation of disruptive technologies such as advancements in ICT, mobile technologies, internet of things, and location-aware devices in the context of geospatial sciences. In this regard, AIOU has a dire need to make use of above mentioned technologies especially the geospatial technologies in order to make informed decisions for the distance education management for student, tutor and exam-center allocation. The efficient use of geospatial technologies is still lacking in distance education which makes the proposed project very interesting from both commercial and research viewpoint.

Geographic Information System (GIS) is a computer based system which is used to manage, store and analyze spatial data [3]. The applications of GIS are almost in every field and can be applied when there is a need to process the data in spatial context. The system is usually a computer based interactive software which is used by the user for making sense of the data and support in decision making. The current research builds on previous work [4], which highlight the importance of GIS based support for students and study center allocation in distance learning. The study is aimed at developing a GIS based System which takes into account the geographical location of students, tutors and study centers and allocates the nearest resources to the students. This increases social aspects by involving in activities organized by AIOU and communicates effectively while learning.

The remainder of the paper is as follows: Section 2 elaborates a detailed literature review on distance education and use of technologies. Materials and methods for our proposed approach is outlined in Section 3. Section 4 presents interesting results and findings on the subject. The conclusions and direction to future work are given in Section 5.

2. Related Work

Many studies have been conducted on the problems and issues faced by students in distance learning mode from institution viewpoint. Simultaneously, numerous technological solutions to those problems have been suggested in these studies. Mir (2017) highlighted the importance of systemic support to students in Open and Distance Learning and suggests an online integrated student support system which can reduce the administrative problems of Open and Distance Learning (ODL) students [5]. Beldarrain (2006) pointed out that researchers are always concerned

[1] Allama Iqbal Open University, URL: http://www.aiou.edu.pk

about the problems faced by the distance educators and the student, which needs to be addressed through emerging tools and technologies [6]. The relationship between technology and learning in distance education has been proved [7]. The authors provide in-depth analysis on online learning methodologies including concepts, strategies and applications.

Emerging technologies such as Web 2.0 [8], are creating new opportunities for distance educators and learners in real time which is improving the efficiency and overall effectiveness of distance education. Some of the salient features of Web 2.0 are open communication, improved social interactions and user generated content. These technologies when implemented bring a new dimension in distance learning by creating new models while assigning new roles to students and instructors. Chickering and Ehrmann (1996) analyzed the usage of advanced technologies in education and provided some principles in distance learning [9]. For example fast communication between the learner and the instructor, prompt feedback and quick delivery without focusing on the delivery method which is otherwise challenge in absence of innovative tools and techniques.

Virtual and online university systems have made achievements in recent years. However, there are challenges in some countries because of the poor communication system, weak internet infrastructure and sometimes lack of support from the political government [10]. A related phenomenon that needs deliberation is the social presence which is of utmost importance in distance learning. The social presence enables distance leaner to be comfortable in interacting with peers and instructors. Social presence is a prerequisite in online learning as it makes the leaner able to interact and collaborate [11]. Social presence can be incorporated and increased by relying on new tools and technologies in distance learning to make the leaners comfort level higher.

Viberg and Grönlund (2017) indicated the usage of tools and technologies by students to support their learning because of flexibility, reliability, round the clock connectivity and its interactive nature [12]. Students learn things as convenient to them because the information they want to access is available to them round the clock without any issues and hurdles. Quick delivery is another major concern in open and distance learning in case of Pakistan where the Government of Pakistan (GoP) and Higher Education Commission (HEC) are continuously making efforts to make the overall performance efficient [13]. The initiatives taken by the GoP and HEC are in the right direction especially with new Digital Policy of Pakistan announced recently. However, there is a room for improvement in this sector. AIOU provides some online web based services which is still not widely accepted due to lack of awareness to access web based systems especially in the remote areas. On the contrary, interactive systems and easy to use websites improve the overall effectiveness of online web based service [14].

One of the major concerns in distance education from the cognitive perspective is the transactional distance. This is defined as the cognitive space between the educator, distance learner and the content of distance learning. Moore (1980) suggests that quality in distance learning is improved when the educator and learner have cognitive proximity which can be achieved by employing different strategies [15]. Reducing transactional distance can improve the learner's performance. The use of technology to reduce the transactional distance and increase learner's performance have been rated well in distance learning [16].

Kagwa and Kambyashi (1997) indicated the importance of using advanced database technologies integration in distance learning which will improve the overall quality of distance

learning delivery by maximizing interaction between the learner and the educator [17]. The usage of technology based support system increases the interest of both learner and educator [18].

The literature discussed above analyzed and addressed different issues and problem faced by students and educators in distance learning mode while delivering distance education. However, there is a gap which exists in the literature which is not addressed. From learner's perspective, the inefficient allocation is the biggest problem which can be reduced if advanced technology is used for allocation in Open and Distance Learning. Furthermore, the usage of geospatial technologies is common in many areas such as agriculture [19], hydrology [20], land use planning [21] and natural resource management [22]. However, no considerable studies are reported on the implementation of geospatial technologies in open and distance learning to reduce the learners and educators' problems and issues. This research aims to present a real case study of AIOU and presents geospatial technologies to solve a very realistic problem.

Geospatial technologies such as traditional GIS sometimes does not support the decision making process sufficiently due to lack of analytical modeling capabilities [23]. This is due to the complex nature of spatial problem which these technologies are unable to capture and the lack of flexibility in these software's. One of the solution to address the complexity of spatial problems in the development of Spatial Decision Support System (SDSS). SDSS is an interactive computer based system designed to support single or multiple users in decision making while solving a spatial decision problem [24]. The complex nature of problems including multiple variables in open and distance learning qualify the usage of SDSS in ODL. Thus potentials of SDSS can be exploited to support decision making in allocation problems in open and distance learning which can be done in future studies.

3. Materials and Methods

This section presents the material and methods. First of all data was acquired from Allama Iqbal Open University. This data predominantly consisted of student's addresses and study centers of Islamabad and Rawalpindi cities. This data was preprocessed for further analysis. Spatial data consisting addresses of students and study centers are then Geocoded[2]. Geocoding is the conversion of text addresses to coordinates for proper visualization in processing in GIS. These addresses were geocoded using Google Maps. This was the biggest challenge due to non-standard addresses system in Pakistan. In Pakistan, every city has their own address schemes. One of the options we have considered is that students may provide their geolocation's while registering online when applying for admissions in the university. This will reduce the burden of geocoding addresses manually and saves a lot of time. The detailed methodology for the study is shown in Figure 1.

[2] Geocoding was done in Google maps by searching addresses one by one

Peer-reviewed version available at ISPRS Int. J. Geo-Inf. 2018, 7, 185; doi:10.3390/ijgi7050185

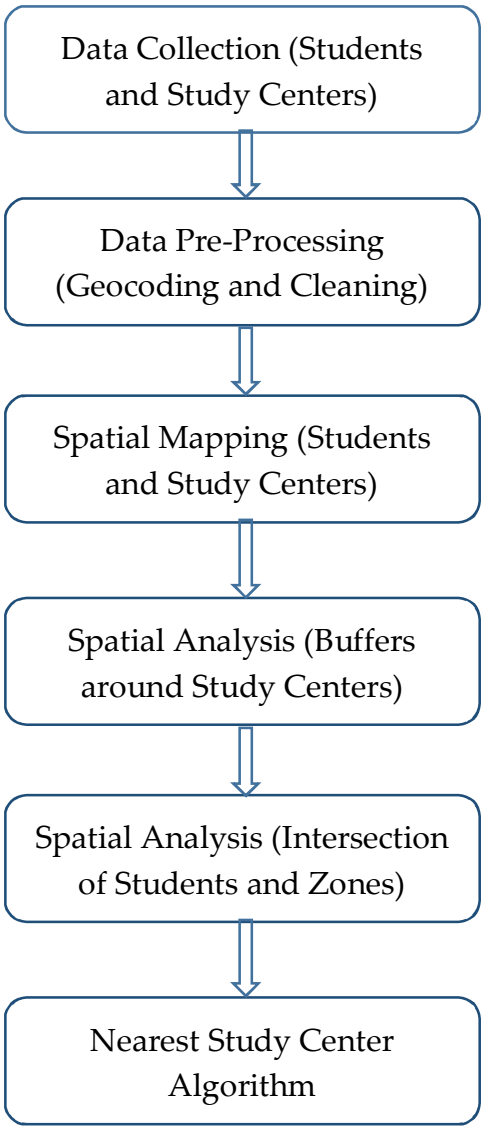

Figure 1. Detailed Flow Chart of Methodology

The geocoded addresses of students and study centers are visualized in ArcGIS[3]. It is assumed that study centers should be within 2 kilometers distance of students. This will ensure students does not face any difficulties while communicating with the tutors during the whole process of distance learning. Several scenarios were run with different distance buffers and 2 kilometers was found to be reasonable accessible distance. Rounded buffers of two kilometers are created around every study centers and intersection operation was applied on the data which provides the number of students and their details within the proximity of each buffer indicating the suitable study center for that student. Finally the spatial algorithm for finding the nearest study center was performed which provides a fair picture to decision makers on allocation of exam centers. Section 4 presents the results and discussion.

[3] ArcGIS is a proprietary GIS software developed and maintained by ESRI (Environmental Systems Research Institute), http://www.esri.com

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 3 April 2018 doi:10.20944/preprints201804.0030.v1

Peer-reviewed version available at ISPRS Int. J. Geo-Inf. 2018, 7, 185; doi:10.3390/ijgi7050185

4. Results and Discussion

Geocoded locations of data (students and study centers) from Rawalpindi and Islamabad were mapped. In Geocoding the textual addresses are converted to geographical coordinates. In this study, the geocoding was done by searching the text addresses and mapped after pointing the location out in online mapping applications. The study centers of Rawalpindi and Islamabad can be seen in Figure 2. The data is overlaid on OpenStreetMap (OSM) data which gives a fair coverage of Volunteered Geographic Information (VGI) in the twin cities. Each study center has a detailed attribute information attached to this which can be seen on a single map click.

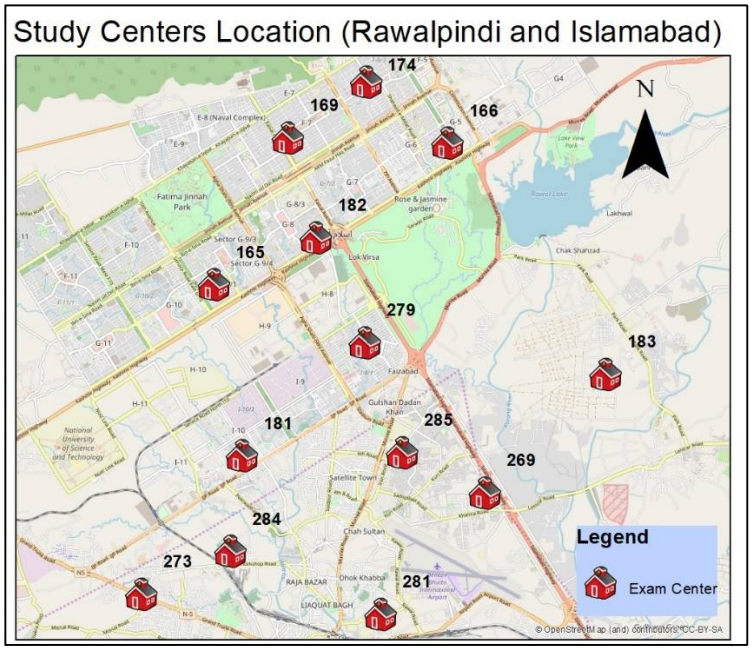

Figure 2. Study Centers (Rawalpindi/Islamabad)

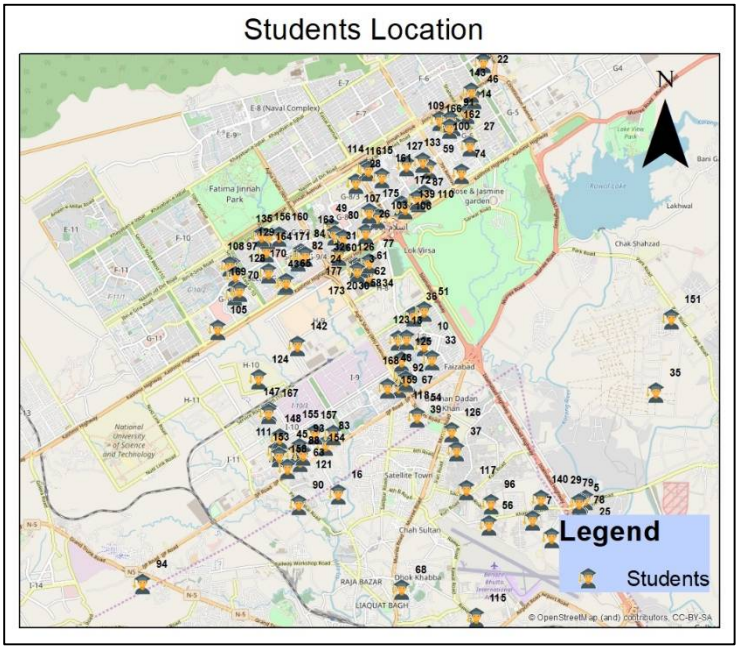

Figure 3. Students Locations (Rawalpindi/Islamabad)

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 3 April 2018 doi:10.20944/preprints201804.0030.v1

Peer-reviewed version available at ISPRS Int. J. Geo-Inf. 2018, 7, 185; doi:10.3390/ijgi7050185

The next step was mapping of all students. For this purpose, Figure 3 shows the geographical spread of students across the twin cities. The map concentration can be clearly can be seen and can be used to get further insights such as hot spots analysis. Each student icon on map can be clicked or searched to bring a detailed information for university management (see Figure 4).

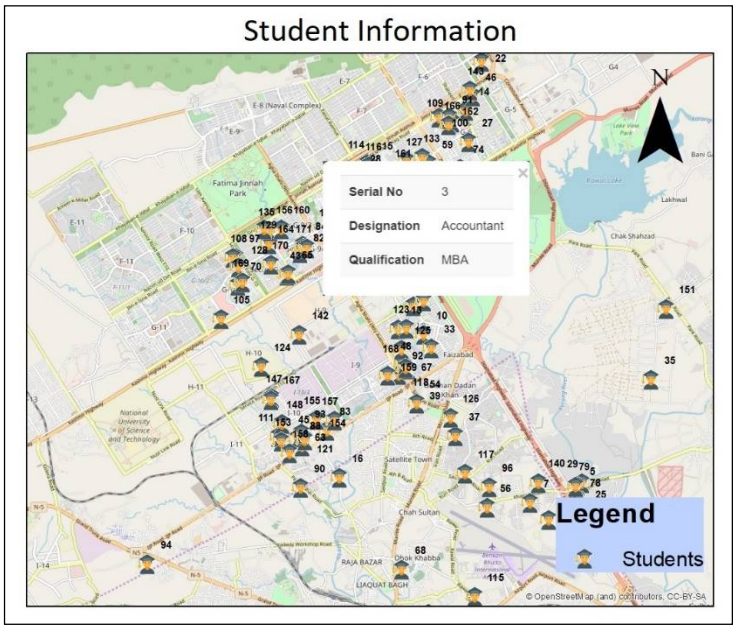

Figure 4. Student Information

Two kilometers proximity is assumed as a feasible distance for students to ensure easy interaction between the student and their tutors and study centers. The algorithm auto generated two kilometers buffer around each study center. This indicates the students residing in those areas are suitable to be allocated to that specific study center. This is demonstrated in Figure 5.

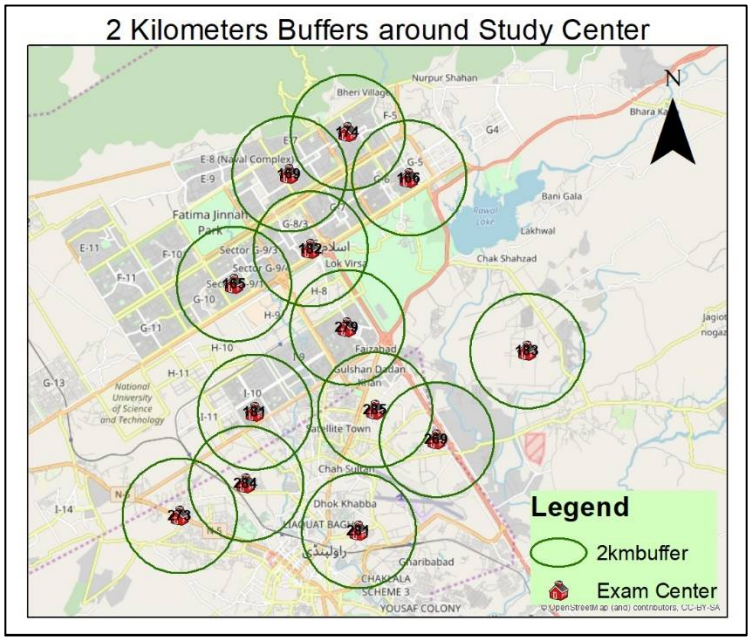

Figure 5. Two Kilometers Buffers around Study Centers

The next step was to assign the study center allocated to each student. The algorithm was run on the available dataset. The results can be seen in Figure 6 where each student is assigned a tutor based on distance proximity. For detailed analysis, a spatial query was formulated to see which exam centers are assigned to which students. The web interface has been interactive which supports likewise spatial queries that will assist management to conduct planning on map.

Table 1 shows that center 281 is allocated to students having identification numbers 141,115 and 68. This indicates that only three students are allocated to that center. There is also a complicated case when one student is allocated to more than one exam center i.e. student serial number 96 has been assigned to more than one study center (269 and 285).

A study center serial number 269 is located in Shakrial, Near Zia Masjid, Rawalpindi which is in close proximity to study center serial number 285 which is located near Chour Chowk, Rawalpindi. The distance between both the study centers is 2.85 kilometers while their distance from the residential address of student number 96 is 1.63 kilometers and 1.8 kilometers respectively. This brings the students within two kilometer proximity to both study centers. There is a filtering mechanism in tier 2 of the algorithm which resolves this complexity.

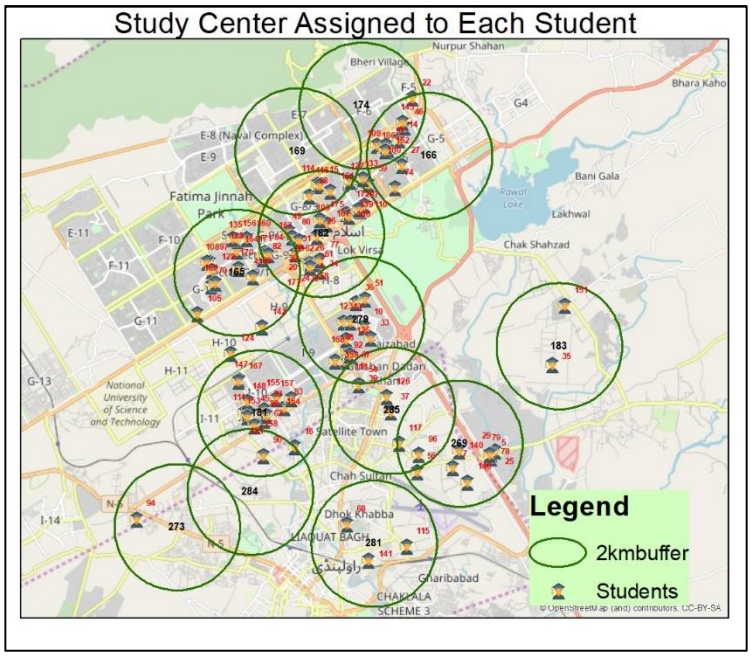

Figure 6 Study Center allocation

213

214 **Table 1.** Study Centers allotted to Students

Center ID	Center Name	Student Serial
281	Sirsyed High School Tipu Road, Rawalpindi	141
281	Sirsyed High School Tipu Road, Rawalpindi	115
281	Sirsyed High School Tipu Road, Rawalpindi	68
273	Govt. Degree College for Women Peshawar Road Near Chour Chowk Rawalpindi	94
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	146
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	56
181	Islamabad Model College for Boys St. No. 17, I-10-1, Islamabad	90
284	Govt. Higher Secondary School Loco Shed, Near Railway Hospital Rawalpindi	90
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	96
285	Govt. Comprehensive Boys High School Dhoke Kashmirian Rawalpindi	96
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	79
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	25
281	Sirsyed High School Tipu Road, Rawalpindi	141
281	Sirsyed High School Tipu Road, Rawalpindi	115
281	Sirsyed High School Tipu Road, Rawalpindi	68
273	Govt. Degree College for Women Peshawar Road Near Chour Chowk Rawalpindi	94
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	146
269	Govt. Faiz ul Islam High School No. 2, Shakrial, Near Zia Masjid Rawalpindi	56

215

216

5. Conclusions

This study proves that geospatial technologies can be efficiently used to address allocation problems in open and distance learning. Deploying simple yet effective techniques assist in improving the overall operational capacity of distance education such as allocation. Assigning distance educators and study centers based on geographical proximity will help reduce the physical and cognitive distance between the learner and distance educator which is a dire need for improving the performance of ODL education especially with the case of AIOU.

There are a few limitation associated with this study which needs to be addressed and improved. For example, the proposed system in current study must be interoperable with existing system of AIOU. Currently they are on slightly different architecture and our proposed technological stack can easily be integrated. The geocoding in longer run needs to be automated. Currently there is no standard addressing scheme which is followed across the country. However, a standard addressing can be proposed where existing addresses can fit with the help of efficient algorithm. Another aspect is related to assigning distance proximity. This can over allocate in case of urban areas where population density is higher and under allocate in case of rural areas where the population density is relatively smaller. This is left for future work.

Study centers allocation in this study only takes into account the geographical location of the students and does not take into account other necessary details for allocation such as the course details, gender of students, discipline enrolled and facilities available in the study center. Similalry, work can be further expanded by including 'Analytics' in future studies. Online and distance leaners create huge semi structured data which can be used to make informed decisions. Analytics plays a vital role while designing new applications utilizing the data provided by users interacting with different applications [25].

SDSS has the potential to address the issue of allocation in a more detailed manner as compared to simple geospatial technologies. AIOU is the largest open and distance learning education in Pakistan which can exploit the potentials of SDSS for tutors and study centers allocation considering multiple factors and different alternatives. Online and distance learning education has a large user base of potential users all over the world as fewer resources are needed to acquire skills. Online and distance learning inflows are roughly $6 billion over the last five years [26]. This implies that systems designed for solving allocations problems in online and distance learning has the potential to target the industry and make an impact.

Although the study proved to be effective in solving the allocation problems in twin cities, in future, we aim to make a completely independent and integrated web based software solution for addressing allocation problems.

Acknowledgements: This study is financially support is provided by Higher Education Commission (HEC), Pakistan under the National Research Program for Universities (NRPU). Data for this study was provided by Allama Iqbal Open University (AIOU), Islamabad. The authors grateful acknowledge their support.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Keegan, D. (1988). Concepts: Problems in defining the field of distance education. American Journal of Distance Education, 2(2), 4-11
2. Dabbagh, N., & Bannan-Ritland, B. (2005). Online learning: Concepts, strategies, and application. Prentice Hall.
3. Chang, K. T. (2006). Geographic information system. John Wiley & Sons, Ltd.
4. Mir, K. (2017). Design and Development of Online Student Support System. Pakistan Journal of Distance and Online Learning, 3(1), 1-8.
5. Mir, K., & Kanwal, S. (2006). Spatial Decision Support System for Tutor and Study Centre allocation for Distant Learning Institutes/System.
6. Beldarrain, Y. (2006). Distance education trends: Integrating new technologies to foster student interaction and collaboration. Distance Education, 27(2), 139-153.
7. Dabbagh, N., & Bannan-Ritland, B. (2005). Online learning: Concepts, strategies, and application. Prentice Hall.
8. O'Reilly, T. 2005. What is Web 2.0? Design patterns and business models for the next generation of software. http://oreillynet.com/1pt/a/6228.
9. Chickering, A. W., & Ehrmann, S. C. (1996). Implementing the seven principles: Technology as lever. AAHE Bulletin, 49, 3-6.
10. Darkwa, O., & Mazibuko, F. (2000). Creating virtual learning communities in Africa: Challenges and prospects. First Monday, 5(5).
11. Ubon, N. A., & Kimble, C. (2004). Exploring social presence in asynchronous text-based online learning communities (OLCS). In Proceedings of the 5th International Conference on Information Communication Technologies in Education (pp. 292-297).
12. Viberg, O., & Grönlund, Å. (2017). Understanding students' learning practices: challenges for design and integration of mobile technology into distance education. Learning, Media, and Technology, 42(3), 357-377.
13. Arif, M., Ameen, K., & Rafiq, M. (2017). Assessing distance education students satisfaction with web-based services: A Pakistani's perspective. Online Information Review, 41(2), 202-218.
14. Wijayaratne, A., & Singh, D. (2010). Is there space in cyberspace for distance learners with special needs in Asia? A review of the level of Web accessibility of institutional and library homepages of AAOU members. The International Information & Library Review, 42(1), 40-49.
15. Moore, M. G. (1993). Theory of transactional distance. Theoretical principles of distance education, 1, 22-38.
16. Rabinovich, T., Berthon, P., & Fedorenko, I. (2017). Reducing the distance: financial services education in web-extended learning environments. Journal of Financial Services Marketing, 22(3), 126-131.
17. Kagawa, O., & Kambayashi, Y. (1997). Advanced database functions for distance education system: VIEW classroom. In Database Engineering and Applications Symposium, 1997. IDEAS'97. Proceedings. International (pp. 231-239). IEEE.
18. Yoshino, T., Munemori, J., & Yuizono, T. (1999). Development and application of a distance learning support system using personal computers via the Internet. In Parallel Processing (стр. 395-402). IEEE.
19. Bill, R., Nash, E., & Grenzdörffer, G. (2011). GIS in Agriculture. In Springer Handbook of geographic information (pp. 461-476). Springer Berlin Heidelberg.
20. Clark, M. J. (1998). Putting water in its place: A perspective on GIS in hydrology and water management. Hydrological Processes, 12(6), 823-834.
21. Ventura, S. J., Niemann, B. J., Sutphin, T. L., & Chenoweth, R. E. (2002). GIS-enhanced land-use planning. Community Participation and Geographic Information Systems, 113-124.
22. McCall, M. K., & Minang, P. A. (2005). Assessing participatory GIS for community-based natural resource management: claiming community forests in Cameroon. The Geographical Journal, 171(4), 340-356.
23. Densham, P. J. (1991). Spatial decision support systems. Geographical information systems: Principles and Applications, 1, 403-412.
24. Malczewski, J. (1999). GIS and Multi-criteria decision analysis. New York: J. Wiley & Sons
25. Sangi, N. A., Mir, K., & Tahir, M. A. (2016). Using analytics to improve learner-centered application design.
26. Piccioli, V. (2014). E-Learning market trends & forecast 2014-2016 report. Athens (GA)-USA.