AAEE 2020

WebLan-Designer (v3) over the Past Six Years: Motivation, Benefits, Evaluation and Reflection

Nurul I. Sarkar; Krassie Petrova
Auckland University of Technology, New Zealand
nurul.sarkar@aut.ac.nz, *krassie.ptrova@aut.ac.nz*

Objective

- Reporting on the design, development and use of a web-based teaching suite (WebLan-Designer v3).
  - This suite was developed with the aim of motivating students to learn TCP/IP networking and Data link-layer protocol design and analysis at introductory level, through interactive, hands-on and simulation-based learning activities.

Background

- Computer science and engineering curricula include s basic courses in local area networks (LANs), transmission control protocol/Internet protocol (TCP/IP) and data link-layer protocol.

- Engaging and motivating students to learn these network fundamentals can be difficult using the traditional lecture format
    - due in part to the limited options of providing students with the resources needed to build computer networks as a way of internalizing the abstract networking concepts taught in class (Huang, 2019)

- The issue was recently exacerbated by the global COVID-19 pandemic where universities had to find new ways of teaching subjects requiring hands-on experience (Gamage et al., 2020).

Research question, contribution, innovation

- **Research question**:   What impact WebLan-Designer v3 has in motivating students to learn TCP/IP and Data link-layer protocols?
  - To address the question, the paper presents the key features of WebLan-Designer v3 and reports on the educational use of the suite by sharing the authors' experiences over the past six years, including the learning objectives underpinning the system design, a description of its functional components, and an evaluation of and refection on its benefits.

- **Contribution**: demonstrating how the purpose build web-based tool effectively motivates students to learn TCP/IP and Data link-layer protocols at introductory level.

- **Innovation**: he development and evaluation of educational suite that effectively complements the delivery of course content both in the classroom, and remotely

Theoretical framework

- **Learner motivation**, or a learner's desire to learn is a personal psychological feature that activates a goal -oriented behaviour (starting to learn). Learners work towards achieving the goal by being **persistent** in their effort to learn, and by **intensifyin**g their intellectual **engagement** with the subject of learning.
    - Stimulating and maintaining learner **motivation** is important as motivation is one of the key antecedents to **academic achievement** (Aluja-Banet, Sancho, & Vukic, 2019; Ross, Chase, Robbie, Oates, & Absalom, 2018).

- Research results have indicated that students learn computer network protocol design and feel more **engaged** with their courses if they are given hands-on experience that illustrates the theoretical concepts (Gotsis, Goudos, & Sahalos, 2005; Sarkar, 2006).
    - In computer networks, he interactions between the numerous components cannot be easily observed →; using simulation and visualization as part of the learning environment may lead to a better understanding of network communication protocols and the way they work (Marquardson & Gomillion, 2018).

Existing tools

- **Ns-2** (Fall & Varadhan, 2020): is a very powerful simulation software package suitable for performance analysis of computer networks. However, it is of limited use as a teaching and learning tool mostly because its text-based interface is not user-friendly.

- **Riverbed Modeler** (Riverbed Modeler, 2020):   commonly used by researchers and practitioners for the modelling and simulation of complex communication networks. A free version of Riverbed Modeler is available (from time to time) for educational purposes. However, the software maintenance cost is quite significant.

- **Cisco Packet Tracer** (Cisco Packet Tracer, 2020): A network simulation/emulation program that can be used by students to experiment with network behavior scenarios, especially with wide area networking, and the Internet. Used widely.

- **EMPOWER** (Zheng & Ni, 2003): A network animator that can be used as an aid to illustrate the concept of wired/wireless networking. However, EMPOWER requires students to have some basic knowledge of computer networks.

- **Cnet** (McDonald, 2020): A network simulator that enables experimentation with various protocols at the data link, routing, and transport layers. However, Cnet requires students to have good knowledge of the Linux/Unix operating system.

- **WebTrafMon** (Hong, Kwon, & Kim, 1999): A web-based tool for network traffic monitoring and review. However, this tool requires an extensive setup for use in classroom settings.

Learning objectives

The following learning objectives guided the design:

- **Knowledge development:** The system should enable students to develop and build their knowledge of network protocol design and analysis.
- **Self-evaluation**: The system should provide students with means of testing their knowledge of computer networking.
- **Problem-solving**: The system should provide students with means to develop and verify network design solutions.
- **Knowledge retention:** The system should provide students with means of reinforcing what was learned in order to achieve deeper leaning and to advance knowledge building.

Architecture

- The system consists of four main modules: Wired LAN, Wireless LAN, TCP/IP Networking, and Data link-layer protocol. The content meets the learning objectives.

- Each module is structured as a set of motivational learning components (tutorial, quizzes, modelling, scenarios, key terms, and review).

  - For example, the components involving computer simulations (e.g., the modelling exercises and the scenarios) aim to support **motivation persistence** by providing an interactive learning experience.

  - The quizzes and the review questions aim to support **motivation intensity** by assisting students to construct their own knowledge and by providing informative feedback on their achievement.

https://weblandesigner.aut.ac.nz
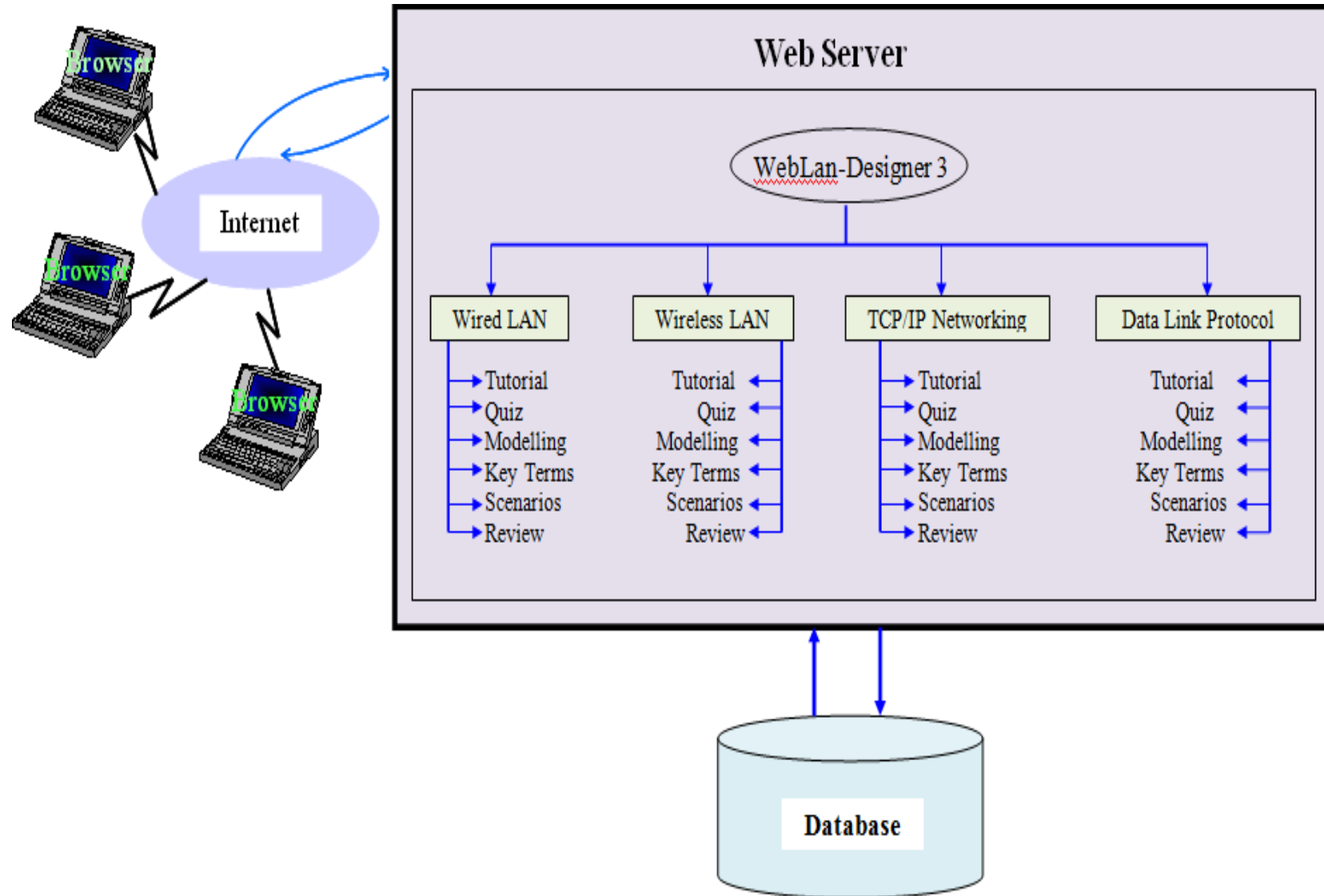
Learning components

- **Tutorials**: a walk-through tutorial for students to complete a set of learning tasks related to network protocol design. Each tutorial includes self-assessment, both at the start and at the end of the tutorial. The tutorials aim to motivate students to embark on a learning journey, by providing a detail rich but easy to comprehend presentation of the key topics.

- **Scenarios and modelling:** provide learners with the means to observe the built-in network design and modelling scenarios Motivation persistency is supported by interactive interface that encourages students to learn by exploring a variety of topologies and thus strengthen their understanding of how the interplay of the network communication protocols shape and govern network traffic.

- **Quizzes and review questions:** Students can test their knowledge of TCP/IP and data link-layer protocol design at any time using the interactive quizzes. Scores are displayed . The review questions (available for each learning module) provide an opportunity for students to reinforce their learning by answering questions and checking their responses against the review question answers. The quizzes and the review questions serve to intensify learner motivation as the learner critically assess their own level of knowledge and understanding and plan their next learning activity.
    - The quiz scores may be useful for educators too, as instructors can use them to gauge students' prior knowledge on network protocol design and fine tune course delivery accordingly.

- **Key terms**: The key terms and definitions aim to support motivation by proving an easily accessible, structured presentation of the main concepts and terms.

Evaluation by students

- A questionnaire about usefulness, ease of use, and effectiveness

- Survey results : WebLan-Designer v3 is a useful and a user-friendly tool with the average per questionnaire ranging from 4 to 5, and overall 4.5 on the average.

- It supports the learning objectives and support motivation engagement

- It supports motivation persistency:

- "*I like especially TCP/IP and Data link protocol modelling aspects. Review questions and answers, and the network scenarios are very useful. Interactive learning through tutorials and quizzes … A very useful resource good for learning and teaching.*"

Informal feedback

- *Hello, I am an IT student here at XX State University, using your site for an assignment for one of my classes. First, I must commend your site, in its ease of use and explanations of terminology and key concepts. However, the portion that is proving to be confusing is the "modelling" application. Again, I commend your site, as it is more user-friendly than most dedicated software programs that I've seen. Thank you.*

- *Could you send me the link to the tool? It sounds very interesting not only as a teaching tool for students but also as a learning tool for practicing engineers. Thank you. (Source: Education technologist.)*

- *Thanks for the link and e-mail. Web-based questions and answers are useful for students. I have experienced that students like to use these for self-review. (Source: Head, education provider establishment.)*

Conclusion

- The WebLan-Designer v3 can be used either in the classroom to enhance traditional lectures, or in remote education scenarios.

- The incorporation of TCP/IP networking allows students to explore this area in more depth by designing and experimenting with their own network topologies; the interactive interface is motivating and enjoyable, thus helping develop and enhance knowledge. In the data link-layer protocol module, students can learn and explore animation-based models, link layer protocols, frames and switches.

- The outcomes of the formal evaluation provide support for the effectiveness of WebLan-Designer v3 as a Web-based teaching that may motivate students to learn TCP/IP networking and Data link-layer protocol design and analysis at introductory level.

- The suite can be used in other disciplines, such as business information systems and electrical engineering. Currently, the suite comprises four modules; it can easily be upgraded to accommodate more practical scenarios and to address feedback obtained from students and academics, including comments posted on the website

References

- Aller, B. M., Kline, A. A., Tsang, E., Aravamuthan, R., Rasmusson, A. C., & Phillips, C. (2005). WeBAL: A web-based assessment library to enhance teaching and learning in engineering. *IEEE Transactions on Education*, *48*(4), 764-771.

- Aluja-Banet, T., Sancho, M. R., & Vukic, I. (2019). Measuring motivation from the virtual learning environment in secondary education. *Journal of Computational Science*, 36, 100629.

- Cisco Packet Tracer. Retrieved September 12, 2020, from https://www.netacad.com/web/about-us/cisco-packet-tracer

- Djordjevic, J., Nikolic, B., & Milenkovic, A. (2005). Flexible web-based educational system for teaching computer architecture and organization. *IEEE Transactions on Education*, *48*(2), 264-273.

- Fall, K., & Varadhan, K. The ns manual. The VINT project. Retrieved September 12, 2020, from http://www.isi.edu/nsnam/ns/doc/

- Gamage, K. A., Wijesuriya, D. I., Ekanayake, S. Y., Rennie, A. E., Lambert, C. G., & Gunawardhana, N. (2020). Online delivery of teaching and laboratory practices: Continuity of university programmes during COVID-19 pandemic. *Education Sciences*, *10*(10), 291.

- Garcia, J., & Alesanco, A. (2004). Web-based system for managing a telematics laboratory network. *IEEE Trans on Education, 47*(2), 284-294.

- Gotsis, K. A., Goudos, S. K., & Sahalos, J. N. (2005). A test lab for the performance analysis of TCP over ethernet LAN on windows operating system. *IEEE Transactions on Education, 48*(2), 318-328.

- Hong, J. W.-K., Kwon, S.-S., & Kim, J.-Y. (1999). WebTrafMon: Web-based Internet/Intranet network traffic monitoring and analysis system. *Computer Communications, 22*(14), 1333-1342.

- Huang, A. (2019). Teaching, learning, and assessment with virtualization technology. *Journal of Educational Tech Systems*, *47*(4), 523-538.

- Marquardson, J., & Gomillion, D. L. (2018). *Simulation for network education: Transferring networking skills between simulated to physical environments*. Paper presented at EDSIGCOM 2018, Norfolk, VA..

- McDonald, C. The cnet network simulator (v3.4.1). Retrieved September 12, 2020, from www.csse.uwa.edu.au/cnet/

- Vijayalakshmi, M., Desai, P., & Raikar, M. M. (2016). *Packet tracer simulation tool as pedagogy to enhance learning of computer network concept*s. Paper presented at the 4th IEEE International Conference on MOOCs, Innovation and Tech in Education (MITE), Madurai, India.

- Riverbed Modeler. (2020). Retrieved September 10, 2020, from https://www.riverbed.com/sg/products/

- Ross, B., Chase, A. M., Robbie, D., Oates, G., & Absalom, Y. (2018*).* Adaptive quizzes to increase motivation, engagement and learning outcomes in a first year accounting unit. *International Journal of Educational Technology in Higher Education*, 15(1), 30.