**Software Practicum: Annotated Bibliography**

The annotated bibliography presented here aims to explore and highlight key resources essential for the development of an online learning management system (LMS). With the rapid advancement of technology and the increasing demand for remote learning solutions, the need for effective online education platforms has become more critical than ever. This annotated bibliography curates a selection of scholarly articles, books, and other authoritative sources that offer insights, strategies, and best practices for designing, implementing, and managing online learning environments. Each annotation provides a brief summary of the resource's content, highlighting its relevance, key findings, and contributions to the field of online education and LMS development. By compiling these resources, this annotated bibliography serves as a valuable reference for educators, instructional designers, administrators, and policymakers seeking to leverage technology to enhance teaching and learning experiences in virtual settings.

**Software Architecture – Cloud Architecture**

AL Busaidi, J. A. M., & Hayat, M. (2017). Smart E-Learning System Architecture based on Cloud Computing. *Journal of Student Research*. <https://doi.org/10.47611/jsr.vi.545>

The study introduces the concept of cloud computing as a solution for educational institutions to manage IT resources efficiently within budget constraints. It emphasizes the role of cloud technology in providing ubiquitous access to learning materials and enhancing productivity through virtualization. The authors identify shortcomings in traditional teaching methods, highlighting issues such as lecture-centered approaches, limited student engagement, and lack of emphasis on critical thinking. They argue that modernizing education through cloud-based technologies can address these challenges.

The paper proposes a smart e-learning system architecture based on private cloud infrastructure. This architecture is designed to enhance educational services by integrating existing IT technologies, such as virtualization and data synchronization. By leveraging private cloud benefits, the proposed system aims to improve scalability, flexibility, availability, and security. It allows educational institutions to create and share various forms of learning content through the cloud platform. This approach not only reduces IT operational costs but also provides a more economical, securable, and reliable method for delivering educational services. The architecture is intended to optimize the utilization of IT resources while ensuring the quality of the learning and teaching process. Through features such as software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS), the proposed system offers enhanced educational experiences for both educators and learners.

Hendradi, P., Khanapi, M., & Mahfuzah, S. N. (2019). Cloud Computing-Based E-Learning System Architecture in Education 4.0. *Journal of Physics: Conference Series*, *1196*, 012038. <https://doi.org/10.1088/1742-6596/1196/1/012038>

The paper discusses the architectural design of cloud-based e-learning systems within the context of Education 4.0, emphasizing the importance of leveraging cloud computing technologies to enhance the efficiency and effectiveness of online learning platforms. The architecture proposed in the study is structured into several layers, including infrastructure, software, resource management, service, and application business layers. Each layer serves a specific purpose in facilitating the delivery of educational content and managing the learning process.

According to the paper,instructors play a pivotal role in this architecture as collaborative knowledge creators, utilizing AI-based learning portals to facilitate interactive learning experiences. Chatbot applications are integrated into the system to assist teachers in various tasks, such as tutoring, communication, and facilitating Q&A sessions. This collaborative approach aims to enhance student engagement and foster a dynamic learning environment.

Content delivery is a key aspect of cloud-based e-learning systems, with a focus on integrating Open Education Resources (OER) and AI-based adaptive learning systems. These systems personalize learning experiences based on individual student needs and preferences, ensuring that educational content is tailored to maximize student comprehension and retention. The learning process is further enhanced through the integration of social networking features and adaptive learning methodologies. Virtual Learning Environments (VLEs) and Learning Management Systems (LMS) provide the infrastructure necessary to support collaborative learning activities and manage course content effectively.Overall, the paper highlights the significance of architecture in designing effective cloud-based e-learning systems that align with the principles of Education 4.0. By leveraging cloud computing technologies and AI capabilities, educational institutions can create dynamic and engaging learning experiences that meet the diverse needs of modern learners.

Ibrahim, M. F., Adnan, R., Zainol, Z., & Abdullah, N. A. S. (2018). A Private Cloud-Based Video Transcoding Architecture for Project-Based Learning Environment. *International Journal of Machine Learning and Computing*, *8*(2), 164–168. <https://doi.org/10.18178/ijmlc.2018.8.2.681>

The study explores the integration of cloud computing and Web 2.0 technologies to enhance e-learning environments. It highlights the shift from static web environments to dynamic, collaborative platforms enabled by cloud computing. The paper emphasizes the advantages of this integration, such as scalability, reduced infrastructure costs, improved accessibility, and enhanced collaboration. It presents a three-layered architecture comprising the Cloud Model Layer (public, private, hybrid clouds), Service Model Layer (SaaS, PaaS, IaaS), and Application Model Layer (content creation, delivery, administration, student management). The clpud model layer deals with the types of clouds and their deployment models, including public, private, and hybrid clouds. Public clouds are owned and managed by third parties, while private clouds are internally owned and provide complete control over resources. Hybrid clouds combine elements of both public and private clouds, offering flexibility and scalability.

The service model layer focuses on cloud services provided to users, including Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). SaaS offers on-demand software applications, PaaS provides runtime environments and middleware, while IaaS offers virtualized computing resources like servers and storage.Lastly, the application model layer encompasses various modules for e-learning application functionalities, including content creation, delivery, administration, student management, and assignment. These modules enable the creation, distribution, management, and assessment of educational content and activities within the e-learning platform. The authors claim that such an architecture leverages cloud computing and Web 2.0 technologies to provide scalable, efficient, and interactive e-learning environments. They emphasizes the advantages of this integration, such as improved accessibility, reduced infrastructure costs, enhanced collaboration, and security. Overall, the architecture is designed to enhance the teaching and learning experience by leveraging the capabilities of cloud computing and modern web technologies.

**Application Architecture**

Washizaki, H., Ogata, S., Hazeyama, A., Okubo, T., Fernandez, E. B., & Yoshioka, N. (2020). Landscape of architecture and design patterns for IoT systems. *IEEE Internet of Things Journal*, *7*(10), 10091-10101.

"Landscape of Architecture and Design Patterns for IoT Systems" presents a systematic literature review analyzing existing Internet of Things (IoT) architecture and design patterns. Essentially, the authors reviewed academic papers and extracted 143 patterns from 32 papers. They classified the patterns based on abstraction level, domain specificity, and quality attributes addressed. Key findings were that 57% of patterns were not IoT-specific, most IoT design patterns were generalized, while many IoT architecture patterns were domain-specific, and common quality attributes were compatibility, security, and maintainability. Besides, the paper provides examples like a layered architecture style, an entity-component-attribute architecture pattern, and an IoT gateway event subscription design pattern. Lastly, the authors argue IoT patterns are not well-shared between research groups and suggest their classification and examples can guide practitioners in reusing patterns. They also identify areas for future IoT pattern research. Consequently, the well-structured methodology, analysis of existing research, and practical implications make this a valuable contribution.

Akhtar, N., & Ghafoor, S. (2021, June). Analysis of Architectural Patterns for Android Development. In *Conference: Analysis of Architectural Patterns for Android Development-SDA* (Vol. 1, No. 1, pp. 1-8).

This paper analyzes and compares different software architectural patterns for Android application development. The patterns examined are Model-View-Controller (MVC), Model-View-Presenter (MVP), Model-View-ViewModel (MVVM), Clean Architecture, and VIPER. The comparison focuses on testability, coupling, maintainability, and reusability. Notably, the paper finds that MVC can lead to highly coupled components, making refactoring difficult, while MVP promotes simplicity and reusability for greater testability. VIPER, conversely, makes code more reusable and testable but has a steep learning curve, whereas MVVM is good for small projects but struggles with larger codebases. Combining MVVM and Clean Architecture provides separation of concerns and leverages data binding. The conclusion is that while no single architecture is best for all Android projects, MVVM with Clean Architecture supports testability, cohesion, maintainability, and reduced coupling well. Moreover, it combines the benefits of MVP's separation of concerns with MVVM's data binding. The model handles operations, and the view has minimal logic. Consequently, MVVM with Clean Architecture is a good candidate architecture for many Android developments.

Petcu, A., Frunzete, M., & Stoichescu, D. A. BENEFITS, CHALLENGES, AND PERFORMANCE ANALYSIS OF A SCALABLE WEB ARCHITECTURE BASED ON MICRO-FRONTENDS.

The authors analyze a scalable web architecture's benefits, challenges, and performance based on micro-frontends. In essence, it compares monolithic and microservice architectures, finding microservices offer greater flexibility, scalability, and easier continuous delivery and deployment. Micro-frontends apply these microservice principles to front-end web development, splitting UIs into independent, deployable units owned by cross-functional teams. Additionally, the paper outlines composition types like horizontal and vertical splitting of UIs into micro-frontends. It discusses challenges like communication between micro-frontends and backward compatibility. Notably, benefits include incremental updates, decoupled codebases, independent deployments, and autonomous teams. It also finds that the module federation performs best overall. The authors conclude that micro-frontends show promise for overcoming monolithic UI challenges through greater agility, efficiency, and developer independence, though more research is needed on enterprise-scale applications.

Maliki, B. I., Kusuma, J. W., Tabrani, M. B., & Hamidah, H. (2021). Identification of education in Indonesia and learning models in student learning with learning management system (LMS). *International Journal of Economy, Education and Entrepreneurship*, *1*(1), 37-46.

The authors identify major issues with education in Indonesia, including problems with equality, quality, efficiency, relevance, and lack of ICT utilization. After that, they explore how learning models using Learning Management Systems (LMS) like Moodle, Claroline, and others can help address some of these problems. The paper also analyzes how LMS facilitates broader, more varied learning without time or place constraints using multimedia content. In addition, it discusses how LMS features like content management, activities, grading, etc., support customized learning. The authors outline LMS models like Moodle, Claroline, Dokeos, Docebo, ATutor, Chamilo, and OLAT that provide open-source options. Besides, the paper suggests that LMS can help address efficiency, quality, and ICT utilization issues in Indonesian education. Adopting LMS appears to be a promising approach to modernize and strengthen the country's education system by expanding access, improving quality, and increasing technology utilization. Subsequently, this could help overcome key challenges around equality, relevance, and lack of ICT use facing Indonesia's education system.

Sotnik, S., Manakov, V., & Lyashenko, V. (2023). Overview: PHP and MySQL Features for Creating Modern Web Projects.

This article overviews PHP and MySQL for creating modern web projects. It discusses the widespread use of PHP due to its dynamic nature, allowing changes at any development stage. Notably, the popularity of PHP stems from its economy, scalability, simplicity, and compatibility. The paper also reviews popular domains for PHP programming, like startups, agencies, and software companies. Furthermore, it examines top PHP frameworks CodeIgniter, CakePHP, and Symfony, highlighting their open-source nature, simple interfaces, and free availability. The paper determines PHP is a powerful tool for complex web projects, retaining popularity alongside MySQL for flexible user data systems. It details user authentication and personalization mechanisms vital for commercial web projects. Examples of modern web interactivity technologies and their logic and PHP requirements are studied. Overall, the properties of PHP and MySQL functions are properly analyzed.

Wu, D. (2022). The application and Management System of scientific research projects based on PHP and MySQL. *Journal of Interconnection Networks*, *22*(Supp02), 2143043.

The author, Wu, presents a web-based system using PHP and MySQL for managing scientific research projects. Essentially, the system adopts a browser/server architecture and utilizes technologies including jqGrid, Layui, jQuery, PHP, and MySQL. It provides modules for project application, online evaluation, process management, and statistics. In addition, the system has been deployed for the Weinan Science and Technology Bureau to manage local research projects since 2018. It features a stable and user-friendly interface to meet daily project administration needs. Notably, benefits include streamlining the project application and review workflow. The system also demonstrates the value of custom PHP/MySQL solutions for research project management across academia, research institutes, and government. Automating tasks like application submission, review, approval, and progress tracking improves efficiency and provides analytical insights. While developed for Weinan, the system's modular design could allow customization for other organizations. Overall, this presents a successful application of PHP and MySQL for building a specialized web platform tailored to collaborative research project administration and oversight. The implementation details can inform similar efforts to use these technologies for workflow automation and data management.

Kurien, A. T. J., Mathew, S. A., & Mana, S. C. (2022, April). Development of PHP and MySQL-based Digital Asset Management System for Secure Organizations. In *2022, the 6th International Conference on Trends in Electronics and Informatics (ICOEI)* (pp. 1859-1863). IEEE.

The article identifies major organizational challenges with asset tracking, including monitoring details like quantity counts, working conditions, maintenance needs, and depreciation tracking. It then explores how an inventory/asset management system can help address these challenges. Moreover, the paper analyzes how such a system facilitates more complete, accessible asset records without physical access constraints using digital interfaces. It discusses how system features like data storage, reporting, and analytics support customized, dynamic tracking [details specific helpful capabilities]. Thereafter, the author outlines system architectures using PHP, React, Bootstrap, MySQL, etc., that provide robust, secure options. Finally, the paper suggests that an asset management system can address issues of tracking inefficiencies and data utilization. Implementing such a system is a promising modernization approach to strengthen asset monitoring by expanding access, improving data quality, and increasing technology utilization. This could help overcome key data and tracking challenges around quantity, condition, maintenance, and depreciation facing organizations' asset portfolios.

Hendriyanto, H., & Cakranegara, P. A. (2022). Web-Based Online Sales Information System Using PHP and MYSQL Database in Nara Collection. *JMKSP (Jurnal Manajemen, Kepemimpinan, dan Supervisi Pendidikan)*, *7*(1), 35-52.

This article discusses the development of a web-based online sales information system using PHP and MySQL for an online shoe store called "Nara Collection" in Indonesia. The system aims to help market and sell products online more efficiently. In this case, the authors use the waterfall software development methodology to design the system. Key features include online ordering, transaction processing, sales reporting, and printing invoices. Notably, the system architecture uses PHP and MySQL for the front and backend, Bootstrap, and other web programming technologies. It enables remote access to sales data and reports to facilitate order-taking and transactions. Overall, the authors conclude that the new system makes the sales process faster and easier than the previous manual methods. It also improves access and printing of sales reports.

Campoverde-Molina, M., Lujan-Mora, S., & Garcia, L. V. (2020). Empirical studies on web accessibility of educational websites: A systematic literature review. *IEEE Access*, *8*, 91676-91700.

This article is about web accessibility and stresses how important it is to ensure that disabled people can use the web in the same ways as everyone else. Notably, a systematic literature review (SLR) of 25 chosen studies is used to look at real-world ways to test how accessible educational websites are. The results show that most evaluations are done automatically, but all teaching websites that were looked at need to fix their mistakes. Consequently, the article says that evaluation methods should be improved by using a mix of automatic tools, manual methods involving accessibility experts, and evaluations by actual users.

Paiva, D. M. B., Freire, A. P., & de Mattos Fortes, R. P. (2021). Accessibility and software engineering processes: A systematic literature review. *Journal of Systems and Software*, *171*, 110819.

The authors here do a systematic literature review (SLR) of the literature on accessible software development from 2011 to 2019. In essence, it adds to earlier reviews. The study of 94 original works also showcases that the design and testing stages of the software life cycle are the ones that get the most attention. Notably, the study finds articles about accessibility and setting up software processes for the first time. This shows that accessibility is not just a feature of the finished product but changes throughout the software life cycle. With an emphasis on accessibility, the goal is to give designers and developers a fresh look at methods and tools that make software development better. Subsequently, the piece points out problems and gaps that need more research, adding to the ongoing conversation about digital inclusion.

Sauer, J., Sonderegger, A., & Schmutz, S. (2020). Usability, user experience, and accessibility: towards an integrative model. *Ergonomics*, *63*(10), 1207-1220.

In the area of ergonomics, this paper looks at how usability, user experience, and accessibility all work together. It looks at how these ideas are defined, how they are measured, and what the results are. Even though some people question their usefulness, the article supports using the words usability, user experience, and accessibility as separate but connected ideas. The paper adds the higher-level idea of "interaction experience" (IX) to bring these ideas together. Because these terms cover many different areas, the article suggests using spider charts to show the results of evaluations. The goal is to give professionals a complete picture of how artifacts compare regarding usability, user experience, and accessibility. Practitioners should gain from the proposed integration because it will help them understand these ideas more fully.

Rasmitadila, R., Widyasari, W., Humaira, M., Tambunan, A., Rachmadtullah, R., & Samsudin, A. (2020). Using blended learning approach (BLA) in inclusive education course: A study investigating teacher students' perception. *International Journal of Emerging Technologies in Learning (IJET)*, *15*(2), 72-85.

This study examines how students felt about the blended learning approach (BLA) used in an open education course. Thirty students were interviewed informally, and the data showed that they were most interested in four areas: the Learning Management System (LMS) display, accessibility, rewards, and sustainability. 50.53% of people thought the LMS display was fine, but changes were suggested to make it easier to understand. Those with negative thoughts about accessibility (69.57%) pointed out problems with slow and unstable internet connection. Sixty-six percent of people who thought the BLA was helpful focused on benefits like better learning experiences, more information, different learning methods, flexibility, and independence. Sixty-one percent of those who answered were in favor of BLA's long-term viability, saying that it should be kept going to keep people interested in learning and create a modern, open, and independent learning environment. Overall, the study shows that changes need to be made to LMS and that there are problems with making the Internet accessible. It also indicates that BLA has good effects and will last.

Oliveira, A. C., da Silva, L. F., Eler, M. M., & Freire, A. P. (2020, November). Do Brazilian Federal Agencies Specify Accessibility Requirements for the Development of their Mobile Apps?. In *XVI Brazilian Symposium on Information Systems* (pp. 1-8).

This research discusses governments' global efforts to regulate information technology accessibility, notably for disabled people. Studies show non-compliance in Brazil, which has comprehensive regulations, including web-based e-government services. Brazilian federal agencies' mobile digital government system acquisition and requirements elicitation are the focus. Data was collected through freedom-of-information requests for 24 similar systems. Seven systems had accessibility criteria, eight did not, while others categorized the material as secret or unavailable. According to the Regulatory Compliance Theory, government enforcement and deterrence are minimal. Morality and legitimacy favored accessibility standards. The article emphasizes the necessity for legislative action to solve Brazil's incomplete mobile app accessibility standards, especially for impaired residents.

Alomari, H. W., Ramasamy, V., Kiper, J. D., & Potvin, G. (2020). A User Interface (UI) and User eXperience (UX) evaluation framework for cyberlearning environments in computer science and software engineering education. *Heliyon*, *6*(5).

This study discusses the limited research on cyberlearning environments in undergraduate STEM education. The authors stress the significance of assessing these environments for success, design improvement, and user satisfaction. Recognizing the lack of thorough empirical studies and agreed-upon evaluation standards, the research includes several user studies analyzing the usefulness of a cyberlearning environment in Computer Science and Software Engineering courses. The SEP-CyLE example illustrates the proposed evaluation framework's usability and utility assessments. Network-based study of cognitive walkthroughs and heuristic evaluation questionnaires shows statistically significant correlations. UI/UX assessments suited to tasks and users are crucial to improving cyberlearning. SEP-CyLE efficiently performs tasks and improves software development principles while the trials identify design improvements. The essay concludes with suggestions for enhancing SEP-CyLE and future research on computer education cyberlearning environments.

Pacansky-Brock, M., Smedshammer, M., & Vincent-Layton, K. (2020). Humanizing online teaching to equitize higher education. *Current Issues in Education*, *21*(2 (Sp Iss)).

This article compares minority online course success rates to White and Asian peers despite online education's ability to increase access. The ultimate objective is faculty training to design and facilitate inclusive online learning experiences. Culturally Responsive Teaching, Social Presence, Validation Theory, and Universal Design for Learning influence the humanized online teaching methodology. Humanized teaching stresses non-cognitive learning through strong instructor-student interactions and community-building, providing connection and empathy to improve engagement and rigor. The study presents six humanizing tactics with teaching examples and goals for meaningful professional development to promote humanized online teaching.