Reinforcing Learning Management System With OBE-Based Learning Analytics and RIASEC Integration

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Abstract **– The emergence of the COVID-19 pandemic brought unparalleled disruptions in people's way of living. Most transactions are done online to practice social distancing. Face-to-face classes were suspended, forcing educational institutions to migrate into flexible learning modalities. Hence, higher education institutions universally utilize learning management systems (LMS) to manage online classes. During this period, outcomes based education's (OBE) performance was challenging to analyze. This prompted the researchers to explore the integration of OBE learning analytics and RIASEC model into existing LMS to enhance educational outcomes. OBE focuses on achieving student learning outcomes, while the RIASEC model categorizes career interests into six personality types: realistic, investigative, artistic, social, enterprising, and conventional. By combining these frameworks, educators can provide a more personalized learning experience. The integration allows for the continuous monitoring of learners' performance, improves instructional strategies to meet individual needs, and career aspirations. This paper reviews current literature on the benefits and challenges of implementing OBE-based learning analytics and RIASEC in LMS, demonstrating how this approach can enhance student engagement, improve learning outcomes, and align educational activities with career goals.**

The findings suggest that this integrated approach holds significant promise for advancing personalized education and preparing learners for successful careers.

Keywords **– Learning management system, learning analytics, outcomes based education, data mining, RIASEC.**

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1. Introduction

The COVID-19 pandemic has changed people's way of living. People embraced online transactions as a new business modality and an efficient method to lessen illness transmission through social distancing [4]. One of the most affected sectors is the academe, where virtual interactions between teachers and students (online classes) have replaced the traditional face-to-face classes. At the forefront of this new online and hybrid delivery of instructions that various schools has adapted is the learning management systems (LMS) [5]. LMS has become a valuable tool for instruction. Hence, higher education institutions (HEI) deployed LMS to administer, document, and automate the delivery of courses and ensure students' progress toward the intended learning outcomes (ILO) [6]. This is evident in the growth of LMS creators and service providers, who aid the education sector in delivering services in the volatile, uncertain, complex, and ambiguous world.

In recent years, the Philippine educational system shifted to outcomes based education (OBE). The 2012 CMO 46 catalyzed the change in Philippine education. The memorandum circular mandated that all tertiary education must develop curricula to assess educational outcomes and nurture skills for lifelong learning. The mandate includes creating a comprehensive set of curricula to transform Philippine education and assist graduates in meeting industry requirements by equipping them with the skills they need to be competitive, locally and globally [1], [2]. However, the country's transition to OBE was hampered by the COVID-19 pandemic.

The Philippine government's stringent quarantine rules shut down all non-essential establishments, including the education sector. According to UNESCO, 28,451,212 individual learners in the Philippines were deprived of in-person education in 2020 [3]. This prompted HEIs to look for alternative modes of delivering educational instructions to their students without engaging in face-to-face classes. HEIs transitioned to fully online courses and adopted alternative delivery modes and modalities such as blended learning, distance learning, and homeschooling. However, it was difficult to determine whether a program's planned learning outcomes have been met without a face-to-face assessment [4].

LMS has been found to improve students' ability to cope with the pandemic by allowing access to learning materials outside the school premises at any time [5], [6]. Self-paced learning via the LMS has replaced instructor-led instruction as the norm for delivering courses [7], [8]. This accentuates the promotion of learner autonomy as posited in self-determination theory (SDT) by allowing students to complete tasks and assignments independently [9], [10]. LMS creates a rich and engaging environment for teaching and learning, and its use is significantly related to learning effectiveness [11].

Globally, only a few LMS integrated OBE materials and approaches [12], [13], [14]. One such platform offers multi-platform compatibility, Internet of Things (IoT)-based attendance tracking, and augmented reality (AR) technologies [15]. Although these platforms follow OBE-based educational practices, none of them can identify or provide quantifiable benchmark data regarding the accomplishment of OBE objectives, which are anchored on program educational objectives (PEO), program outcomes (PO), and course outcomes (CO) [16]. This becomes a problem, especially during the time-consuming curriculum review, which necessitates a comprehensive examination of all students' outputs by combing through data points such as class records, laboratory activity reports, and other assessment results. In addition, accurate and reliable data are required in reporting OBE accomplishments during national and international accreditations [17]. However, collecting OBE analytics with current learning management systems is not easy.

Data scientists have tried to create OBE analytics platforms. However, developing and implementing a suitable platform for student assessment based on the OBE framework is one of the biggest challenges, primarily because an OBE process requires constructive alignment of all the teaching and learning components to guarantee the accomplishment of intended outcomes [18], [19].

Regrettably, the literature revealed that there is just one university with this capacity, and it utilizes a specialized platform. The platform collects information during class record submission, which provides academic institutions with batch-processed data and OBE analytics. However, it offers a low accuracy of data analysis results as it only captures students' final assessment grades [20]. Therefore, developing an OBE-based LMS that records and examines not only students' final scores but also the assessment tasks in various components is essential.

Thus, this work aimed to introduce a learning management system using a framework that adheres to the standards of outcomes-based education. The framework captured students' assessment scores from various assessment tasks to determine a graduate's level of attainment of skillsets. Holland's occupational themes [57], an OBE-related paradigm, are incorporated into the framework, which is the basis for generating reports of individual learners' progress. A data analytics component is likewise included to analyze and interpret individual students' assessment data and generate analysis reports on learners' competencies.

Furthermore, this work applied the concepts of self-determination theory (SDT) in developing a learning management system that allows students to actively participate in an online learning mode and actively engage with various assessments designed to measure their intelligence and abilities within the different learning domains.

2. Review of Related Literatures

In the previous years, the integration of outcomes based education principles and learning analytics has revolutionized the educational technology sector. This transformation is visible in the design of learning management systems which has evolved from traditional course delivery platforms into a complex and modern system that is capable of delivering personalized learning choices. The combination of OBE based learning analytics with Holland’s RIASEC model (a well known and utilized framework for career matching) offers a promising approach to automate and streamline this system.

This literature review explores the potential of utilizing LMS with OBE-based learning analytics and RIASEC integration, whose aim is to provide insights into how such an approach can improve educational outcomes, cater to personalized student needs, and align assessment outcomes with career aspirations. By examining current research and case studies, this review highlights the benefits, challenges, and future directions of this innovative approach in educational technology.

2.1. Self Determination Theory (SDT)

SDT occupies a unique place in psychology. It emphasizes the fundamental psychological tendencies toward intrinsic motivation and integration and covers the pros and cons of various socially regulated or behaviour-promoting strategies. According to SDT, students tend to learn more when given a set of goals and objectives (i.e., vocation and/or career they like after graduating from college) and a means to monitor their progress concerning subject/topic interests during their learning period [21], [22].

To further emphasize the importance of SDT's role as motivation for the development of an LMS, it is vital to examine a sub-theory of the SDT: the cognitive evaluation theory (CET). CET addresses intrinsic motivation by proposing that students learn following their desire to learn. A specific area of interest for CET is how social settings affect intrinsic motivation or how factors like rewards, interpersonal controls, and ego involvements impact intrinsic motivation and interest [23].

The COVID-19 pandemic has taught us several important lessons that allow further study and initiatives to promote moral character education. According to SDT, character education must constantly support students' needs for competence, autonomy, and positive relatedness as they participate in appropriate learning activities. The conspicuous absence of such support signifies low academic achievement and demotivation. Therefore, creating an online tool that facilitates academic learning is essential even without interpersonal contact [24]. SDT also proposes that students are likely to study harder and strive for intrinsic goals if their needs for autonomy, competence, and relatedness are supported. Educators and parents can support the students' need for autonomy in choosing their learning path by supporting learning options in their decisions. The need for students' competence can be supported through feedback per individual tasks. Respecting students' self-paced learning can also be supported through display of patience by teachers and parents to their children, which promotes relatedness [25].

2.2. Outcomes-Based Education (OBE)

Outcomes-based education (OBE) is an educational theory that embodies and expresses certain beliefs and assumptions about learning, teaching, and the systematic structures within which these activities occur. According to Spady [26], OBE is about organizing an educational system around what is essential for students to accomplish at the end of their learning experience.

This entails developing a clear understanding of the skills students need to possess before planning the curriculum, instruction, and evaluation to ensure this learning occurs. The central idea behind Spady's definition is that OBE is an organizing method, carrying out and assessing instruction that necessitates administrators, educators, and students to concentrate their attention and efforts on the intended educational outcomes expressed in individual student learning [26].

The OBE framework differentiates itself from traditional teacher-centered content-based learning and focuses on learner-driven approaches. The outcomes-based approach emphasizes acquiring the information and skills necessary to attain the objective and the processes connected to the intended outcomes [27]. In this aspect, the teachers' role changes to guiding learners through specific learning procedures to achieve the results rather than being the source of information.

The OBE paradigm sets clear guidelines and standards for determining learning competencies through observable and measurable outcomes. The accomplishment of program outcomes is emphasized in OBE because it serves as the standard by which the efficacy of OBE through program achievement is assessed [28]. Figure 1 gives an overview of OBE's constructive alignment of curricular components. The program educational objectives (PEO) of an OBE curriculum must be directly related to the program outcomes (PO), which are then linked to the course outcomes (CO).

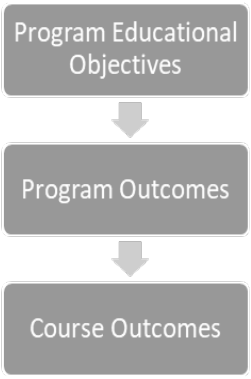

Figure 1. Overview of OBE

Four (4) principles guide the OBE framework: clarity of focus, designing down, high expectations, and expanded opportunities. Clarity of focus refers to establishing and understanding the desired learning outcomes, which serves as the foundation for developing the curriculum [29]. The design down principle advises implementers to begin instructional planning while keeping the culminating outcomes in mind. The high expectation principle raises standards by presenting students with more challenging tasks.

The term "expanded opportunity principle" relates to providing students with more learning opportunities, such as learning time, instructional methods and strategies, and curriculum access [26].

Direct and indirect techniques (Figure 2) are the two most popular assessment types used to determine program outcomes [30]. In an indirect approach, learners are assessed through exit interviews, surveys, focus group discussions, alumni surveys, and careful analysis methods of job placement and retention statistics [31]. Conversely, the direct method uses evaluation techniques for both theoretical and practical components, including exams, quizzes, laboratory results, and projects [32].

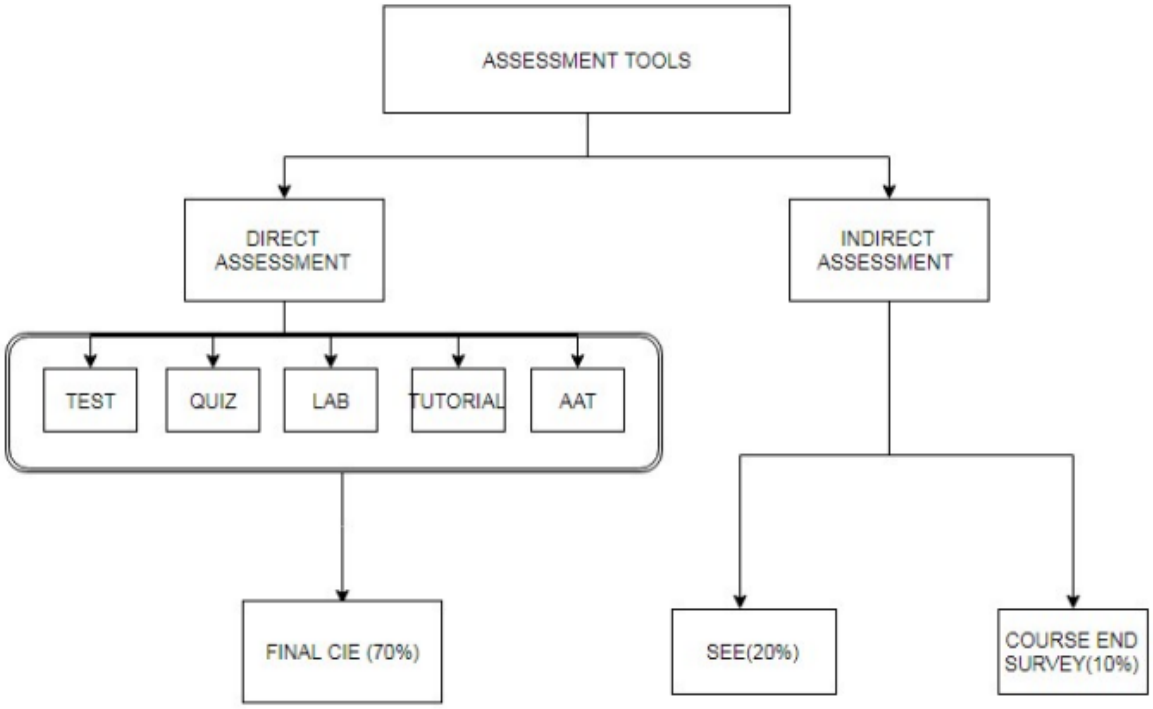

Figure 2. Assessment tools for evaluation of outcomes

OBE teaching-learning programs are only effective if implemented with a well-planned course delivery approach supported by practical teaching, learning, and assessment tools [33]. Over the past years, higher education institutions (HEIs) have developed and utilized LMS as an alternative delivery channel for self-paced learning [34]. According to Qureshi [35], LMS is an OBE tool. Due to the data-intensive nature of assessing the effectiveness of an OBE curriculum, online educational delivery systems such as E-Learning and Learning Management Systems (LMS) are best suited for OBE framework implementation. Analysis of data collected from an LMS can produce valuable information for the decision-making of faculty, colleges, and universities to improve OBE's effectiveness.

2.3. Holland's Occupational Themes (HOT)

The Holland occupational themes (HOT) present a theory developed by John L. Holland throughout his career in occupational therapy. HOT is a theory of human personality that revolves around career and vocational choice, which groups people into suitable occupations.

Holland's various theories and research have mainly focused on people's resemblance to six personality types: realistic, investigative, artistic, social, enterprising, and conventional (RIASEC). Each type is associated with different interests, activities, abilities, beliefs, values, and characteristics [36], [37]. HOT is the most widely used model for classifying and organizing career interests. John Holland developed and designed instruments to capture core knowledge and career classification related to an individual's career development, assessment, and practice [38].

Attempts to incorporate HOT into counselling psychology practice have helped practitioners be guided by its principles and design necessary interventions [38]. In the digital era, HOT has also been incorporated into a self-help standalone computer program called DISCOVER, designed for career guidance [39].

2.4. Learning Management Systems (LMS)

A learning management system (LMS) is an information system that facilitates learning through processing, storing, and disseminating educational materials over the Internet.

It is designed to handle learning content, student interactions, assessment tools, learning progress reports, and other student activities [40]. Many different learning management system (LMS) platforms are in the market, both licensed and open source. The most popular open-source platforms are Moodle LMS and Canvas LMS [41], [42], [43]. Both allow for built-in customization packages and support for external plugins. Many LMS companies offer ready-made Moodle-based LMS and re-branded this to be sold as commercial LMS like Blackboard LMS [43].

There are also custom-built LMS developed using popular PHP frameworks to customize and commercialize educational delivery and administration services online. All of these LMS platforms have similar functions: uploading and viewing educational materials, administration of assessments, providing student-teacher interactions, and delivery of lessons [44].

The precursor to the LMS was the self-paced modular approach using computers as the delivery platform for course materials, the E-Learning Systems. E-learning was the choice for automating course delivery, administering the assessment, and producing assessment analysis. Most E-Learning systems are network-based and can only be accessed through reservations in computing laboratories that cater to them. With the challenges of context-based education, E-learning was later redefined and given new roles to fulfil the needs and fix issues to fit into the needs of modern education [45].

One lacking characteristic of traditional E-learning systems is the absence of interaction between teachers and students. This creates a need for an online learning platform that can be accessed outside university campuses as needed in OBE. This is why most educators augment their E-learning systems using web applications such as emails and social media platforms for personalization and feedback mechanisms. This setup allows for interaction between teachers and students, which traditional e-learning systems lack [46], [47]. With the popularity of social media platforms, the availability of smartphones, and the increase in internet connectivity usage and accessibility, the need for a more personal learning experience based on a student's capability has helped the advent of modern learning management systems. Unlike E-learning applications, LMS provides the much-needed personalization features by providing a venue for giving feedback and recommendations and setting up individual learning paths, allowing for a more personalized learning experience.

LMS became a staple for prominent universities to augment traditional classroom delivery of course contents to make education accessible anywhere at the most convenient time for the students. Only during the onset of the COVID-19 pandemic were all academic institutions required to continue classes in a non-contact environment. The use of LMS became a requirement for schools to operate [3], [48]. With the help of analytics, using LMS has helped keep the retention rate of learners in higher education [49]. Using analytics in an LMS helps detect and identify students at risk of drop-out for proper interventions [50]. LMS is also used to help monitor and streamline the implementation of OBE processes, like delivering course materials and instructions, monitoring learners' progress, and analyzing knowledge and skills gaps [51], [52].

Many top-ranking educational institutions globally chose digital technology as a driving force to help develop students gain quality knowledge [53]. Students "perceived usefulness" of an LMS has the most significant influence on using an LMS platform [54]. In addition, many users acknowledge that online lecturers and facilitators also play an essential role in user engagement, thus increasing the rate of LMS user acceptance. User dissatisfaction can stem from many aspects, like course content, course format, ease of use, and timeliness of the content delivery [55].

3. Student Academic Needs and Assessment for Online Learning (SANAOL) LMS Framework

Student Academic Needs and Assistance for Online Learning (SANAOL) is a learning management LMS framework for outcomes based education (shown in Figures 3 and 4). The design for this framework/model is anchored on the notion that different OBE-related theories can be incorporated within the LMS to extract data from the learners and process this data to produce learning progress analytics. Based on the literature review, a set of rules for determining the effectiveness of OBE in a curriculum and generating a set of analytics was developed.

Obtaining the required data is essential to consider the different assessment tools that can be implemented in an online learning scenario that can be used in an LMS setting. Furthermore, the desired output is achieved by following a series of processes.

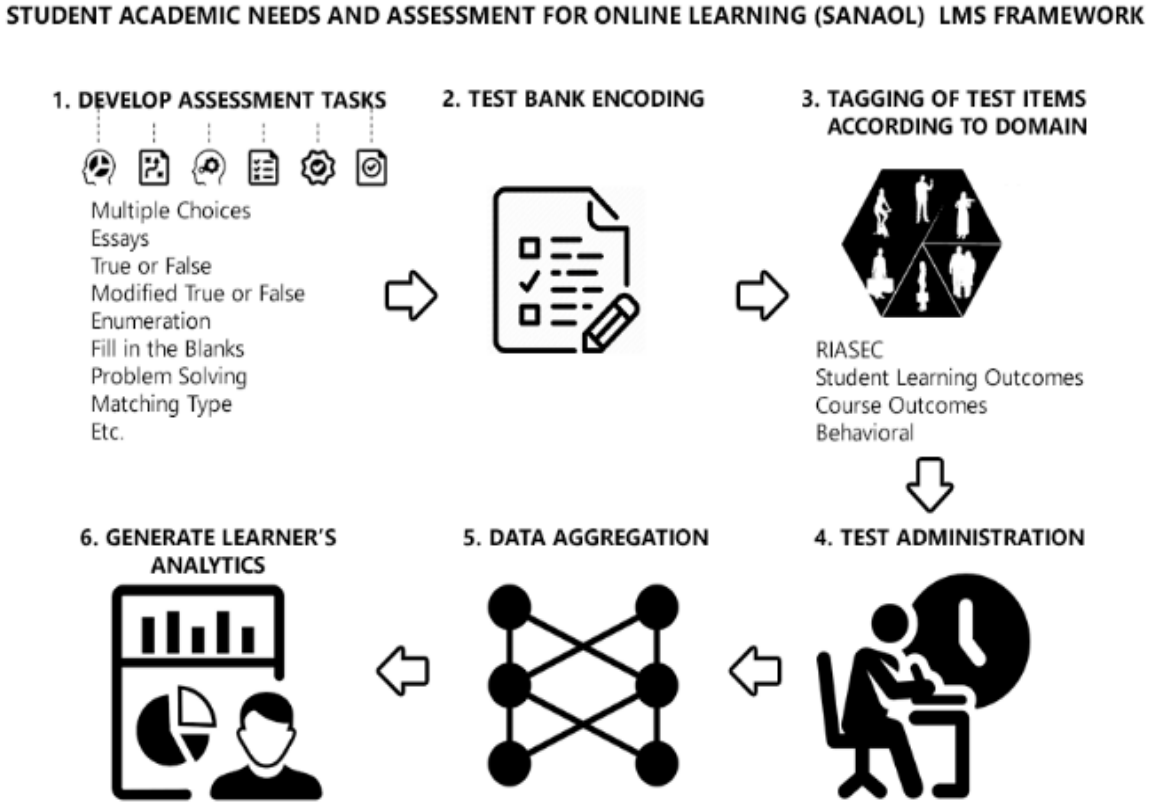

Figure 3. SANAOL LMS framework

3.1. Develop and Identify Assessment Tasks

The first step of the process is developing different assessment tasks that can be administered within the LMS. Administered assessment tasks may be checked automatically by the system, such as multiple choice, true or false, spelling, enumeration, and fill-in-the-blank tests. On the other hand, manual faculty scoring is essential for further tests such as essays, problem-solving, and online submission of projects. It is also crucial that a feedback mechanism is incorporated for each assessment task administration. Therefore, it is essential to identify the different types of assessments that can be administered online. From these different assessment types, course instructors will compile a test bank to determine each student's competitiveness level.

3.2. Test Bank Encoding

The second step is to develop a test bank with various difficulty levels to measure the learners' understanding of the lessons. Each test question will then be tagged for every possible outcome domain that can be attributed (i.e., one or more tag can be attributed per test question). Whenever a student answers a test question, SANAOL LMS automatically aggregates the current test result with the previous test results and records the learner's progress per measured domain.

This allows for the SANAOL LMS to produce real-time learning analytics.

Using OBE approaches as presented and discussed in the literature review, the LMS will then produce a series of learning analytics that will identify the individual competency of the students as well as the overall program outcomes attainment of the academic institutions.

The unique feature of SANAOL against other LMS is that it does not just provide a platform for delivering course instructions. Still, it also produces a detailed analysis of the individual learners' abilities, behaviors, intelligence, etc. This kind of data analytics helps assess the impact of the educational system being utilized by schools and universities, especially in developing strategies for continuous improvement of the educational system.

The desired data analytics are obtained by tagging all assessment questions with related domains such as Holland's occupation themes (RIASEC), student learning outcomes, course outcomes, etc. and aggregating all the results to produce relevant outcomes-based education analysis.

3.3. Tagging of Test Items According to Domains

Tagging test items includes encoding and identification of domains and sub-domains that are used as tags. The following is an example of tag domains that can be done:

Table 1. Assessment domains

Domain	Sub-domain
Career Matching	• Realistic • Investigative • Artistic • Social • Enterprising • Conventional
Course Outcomes (CO)	• 1st Course Outcome • 2nd Course Outcome • 3rd Course Outcome • Nth Course Outcome
Program Educational Objectives (PEO)	• 1st Program Educational Objective • 2nd Program Educational Objective • 3rd Program Educational Objective • Nth Program Educational Objective
Student Outcomes (SO)	• 1st Student Outcome • 2nd Student Outcome • 3rd Student Outcome • Nth Student Outcome

Device/develop different assessment tasks such as:

- Multiple Choice
- Essay
- Problem-solving
- Enumeration
- True or False
- Modified True or False
- Fill in the blanks
- Etc.

Compile a test bank for each assessment task,-develop and tag individual assessment items into one or more tags as shown in Table 2.

Table 2. Sample test bank

Question	RIASEC Category
Do you enjoy taking charge and leading others towards a common goal, even in situations where there's uncertainty or risk involved?	Enterprising
Do you find yourself drawn to activities that involve exploring complex problems, conducting research, and uncovering new information?	Investigative

3.4. Test Administration

Created assessments will be administered to the students via LMS. Students may be given different assessments of varying difficulties.

3.5. Aggregate Individual Learners' Assessment Results

Each learner's answer will be processed for correctness and results are aggregated with the previous scores per learner's domain of assessments taken. This ensures that an accurate real-time learner's analytics is available at any given point in time.

3.6. Generate Learners' Progress Analytics

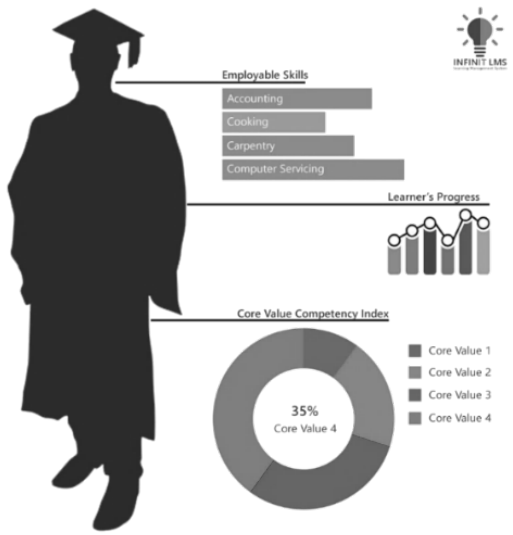

Figure 4. SANAOL LMS learning analytics dashboard

Individual domain's average scores are calculated by simply incrementing each learning domain's values based on answered test actual score and item points.

3.7. SANAOL Learning Analytics Applications

As illustrated in Figure 5, a single test item may be used to aggregate scores of different domains.

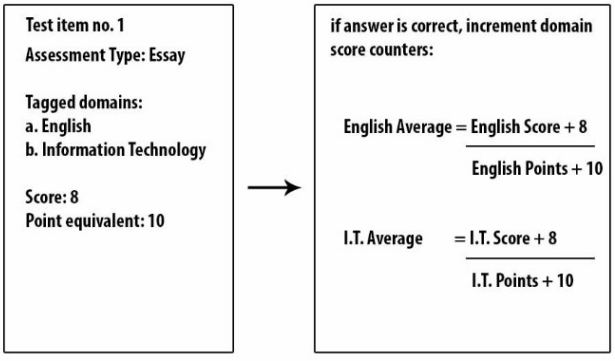

Figure 5. SANAOL LMS learning analytics dashboard

Using the SANAOL Framework as the basis for gathering assessment data, different learning analytics can also be incorporated to offer expanded functionalities and customized data analytics based on the schools' preferences.

3.8. Career Inclination Register Analytics

The career inclination register analytics was explicitly designed for determining prospective first-year college students' career interests based on Holland's occupational themes [56]. The Holland occupation theme codes are primarily used to classify people and job environments, which will assist people in finding the best-fit job based on their personality, interests, and educational achievements [57].

Table 3. Holland's occupational theme codes

Theme Code	Descriptors
Realistic	Agriculture or Nature, Construction, Engineering, Manufacturing, Mining or Energy, Protective Services, Transportation
Investigative	Higher Education, Research, Engineering or Design, Medicine, Science, Computer Industries
Artistic	Visual Arts, Drama, Music, Dance, Literary, Unstructured Environments, Photography, Interior Design, Advertising and Editing
Social	Human Resources, Social Services, Education, Religion, Health Services, Child and Adult Care, Mental health
Enterprising	Sales and Marketing, Government and Politics, Fundraising, Industry and Manufacturing, Business, Hospitality, law
Conventional	Government, Large Corporations, Business Offices, Financial Institutions, Accounting Firms, Quality Control, Business, Education

4. Results and Discussions

System Development

The researchers were able to develop a working prototype of the learning management system using a PHP Laravel framework as the backend and Bootstrap for the frontend. Furthermore, MySQL was also utilized as the relational database management system.

To allow for the collection of assessment data, various assessment tasks were also developed to accommodate a wide-range of test bank tasks. As shown in Table 4, these assessment types are identified as assignments (online submissions), multiple choice quiz, essay type (open-ended questions), problem solving test, true or false, modified true or false, matching type, enumeration, and identification tests.

Table 4. Summary of assessments generated through SANAOL LMS

Assessment Type	No. of Assessments
Online Submissions	9,462
Multiple Choice Quiz	2,797
Essay Type / Open-ended assessments	3,367
Problem Solving Tests	909
True or False	833
Modified True or false	113
Matching Type	479
Enumeration Test	501

Subsequently, the system was also able to incorporate three (3) OBE-related paradigms: non-verbal aptitude, achievement analysis verbal interpretation, and career inclination register (based on Holland's occupational themes).

Testing and Deployment

In the case of deployment, the researchers were able to successfully roll-out a proof of concept at the University of Mindanao through its Student Academic Services Portal.

Area	Score	Description	Interpretation
English	33.33 %	Poor	You can demonstrate minimal understanding across a range of learning areas in English such as oral communication, create fiction and non-fiction, reading and writing, and English for Specific Purposes. See full interpretation details
Mathematics	33.33 %	Poor	You can demonstrate limited ability to solve situational and business-related problem; perform basic statistical procedure and analysis; solve algebraic and trigonometric equations; and can show graph of functions and model figures of regions See full interpretation details
Natural Science	60.00 %	Satisfactory	You can demonstrate adequate understanding of the Earth and life ; composition and properties of matter, rigid bodies, and fluids; waves; heat and thermodynamics, electricity and magnetism; optics; application of scientific knowledge and the solution of practical problems in a physical environment. See full interpretation details
Social Science	60.00 %	Satisfactory	You can demonstrate adequate competencies in social sciences discipline such as politics and governance, religion, society, ethics and philosophy. See full interpretation details

Figure 10. Career inclination register data visualization for RIASEC scores

As shown in Figure 10, the sample learner, having a score of 33.33% has a "poor" rating for all Mathematics courses assessments. The system was also able to give interpretation that the learner can demonstrate limited ability to solve situational business-related problems, perform basic statistical procedures and analysis, and solve algebraic and trigonometric equations.

After developing the learning analytics, 44 k-12 and higher education institutions (HEIs) have participated in the data-gathering process for evaluation or full implementation of the system. One thousand two hundred eighty-seven (1,287) developed various assessment tools, and 14,361 students participated in answering the designed assessments.

Reports Generated

The system generated individual learner's analytics based on each student's aggregated test assessment result across all disciplines. Sample learning analytics were generated as follows:

Career Inclination Register

As seen in Figure 11, this section determines the career interest based on Holland's occupational themes with specific indicators. This test was designed to help learners choose the career or stream most suits them and promote understanding of self. The data points used in these analytics are designed to capture one's core – style, personality, aptitudes, and more. This directly contributes to one's fitment towards one or more careers.

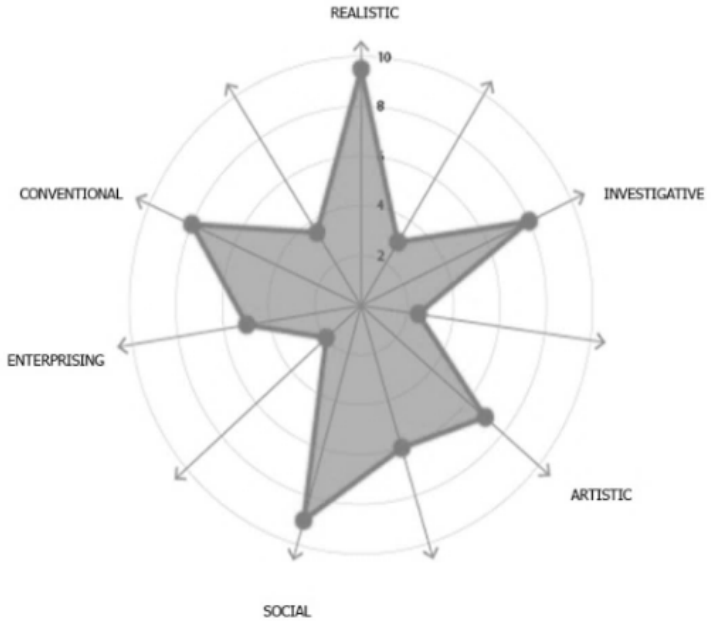

Figure 11. Career inclination register data visualization using radar chart

The career inclination register analytics was designed to use the spider web diagram (also known as radar chart) to allow for the comparison of multiple RIASEC variables across different categories. By plotting each variable on a separate axis and connecting the data points (score per domain), users can visually assess the relative performance or on each RIASEC category. As shown in Figure 11, individuals with a social and realistic personality type, according to Holland's RIASEC model, can be interpreted as having potential career path with the following: Social Work, Counseling, Human Resource Specialist, Community Organization, and Educator, among others.

The system successfully generated different interpretations of each learner's analytics.

These results can later be used to help students pursue more relevant careers, improve weaknesses, and help schools improve curriculum by identifying overall weaknesses within the different domains presented by learning analytics.

Aside from the learning analytics developed, the researcher could also use a comparative advantage table to showcase the competitive advantage analysis (Figure 12).

The sample learner as shown in Figure 12 indicates that the learner has a tendency to be more artistic and less investigative in nature. The learner is given an interpretation of the personality types, suggested programs to take, jobs that are suited to their personality, and even their strength (and weakness) in courses taken.

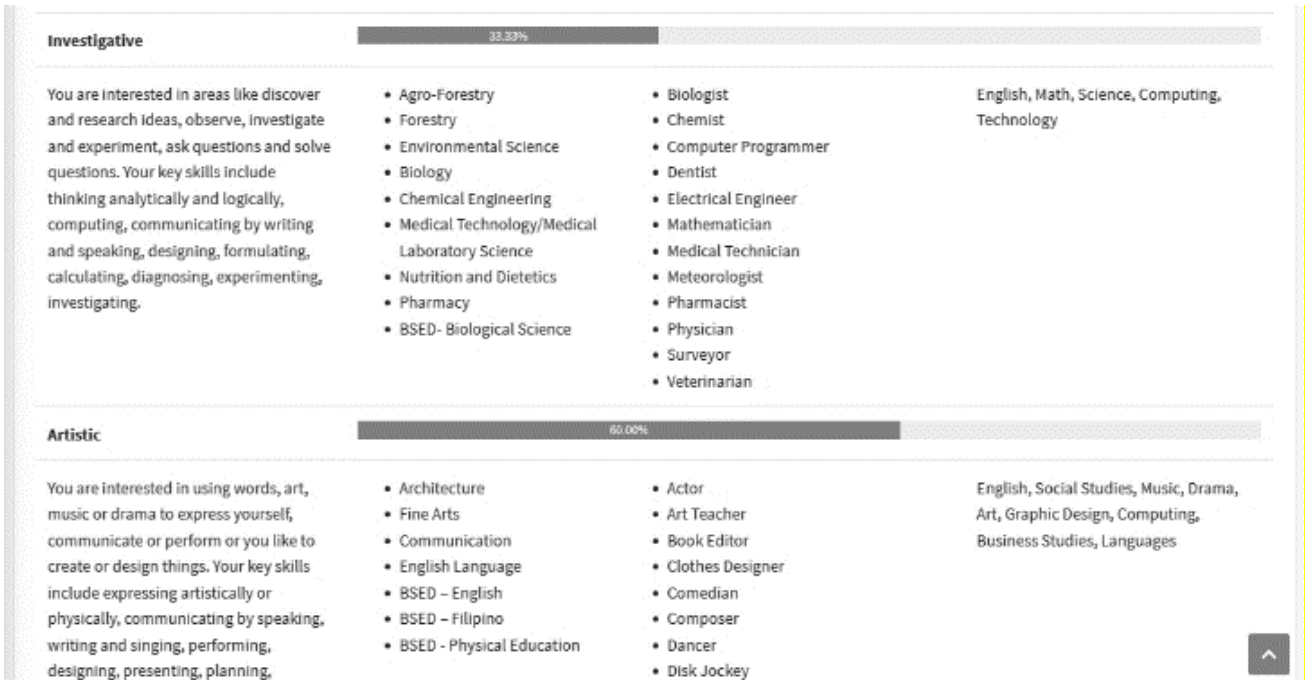

Figure 12. Comparative learner's advantage

5. Conclusion

The holistic approach in gathering students' assessment data from within the LMS makes it less susceptible to generating false results due to data contaminations resulting from the current mood of users during one-time data-gathering from assessments. Since the data gathered by the system are aggregated over a long period (i.e., 12 years K-12 and 4 years tertiary education), the LMS framework is expected to produce accurate real-time and aggregated data analytics.

Using LMS as a tool for conducting online classes and assessments, most academic institutions realized that a fully online learning modality using LMS lacks the functionality needed for producing OBE-related reports, and none of the existing LMS is geared towards the OBE framework.

By doing a benchmark, determining the key metrics, and comparing the SANAOL LMS against other key players in the LMS industry, such as Black Board LMS, Quipper, Google Classroom, and Schoology, it has been observed that the required data analytics necessary to produce an OBE compliant report are missing among all LMS providers. With the use of SANAOL LMS Framework, it was possible to capture the level of learning attainment of each student using direct and indirect assessment methods by incorporating outcomes assessment tools and metrics within an LMS.

The development of an analytics-based LMS framework opens up the possibility of extracting not just learning data from the students but also analyzing different student traits such as behavioral pattern analysis, neuro-psychiatric evaluation, measuring the users' mental wellness, job matching, and skills enhancement.

6. Recommendations

The development and introduction of AI-based domain identification for each test item will improve the efficiency of the SANAOL LMS framework.

Instead of the manual identification of the RIASEC domains during the creation of individual assessment tests, the development of a methodology that will be able to combine the RIASEC model, data mining techniques, and artificial intelligence within an LMS will greatly improve the workflow and improve the accuracy of RIASEC interpretation which can provide students with an accurate personalized career matching recommendation.

While the RIASEC model is most commonly utilized in career counseling and vocational psychology, data mining techniques can also be used to categorize individuals into RIASEC groups based on their preferences and interests

References:

[1]. Sana, E. A., Roxas, A. B., & Reyes, A. L. T. (2015). Introduction of outcome-based education in Philippine health professions education setting. *Philippine Journal of Health Research and Development*, *19*(1), 15.

[2]. Lanuza, M. H. (2017). The Outcomes-Based Education (OBE) Teaching Strategies in Mathematics: Basis for a Proposed Enhanced Teaching Approach. *International Association of Scholarly Publishers, Editors and Reviewers, Inc*, *6*, 64-84.

[3]. UNESCO. (2020). *COVID-19 Impact on Education.* UNESCO. Retrieved from: https://en.unesco.org/covid19/educationresponse. [accessed: 02 March 2024].

[4]. Chan Paul Leong, D. (2022). Outcome-based education in open distance learning: A study on its implementation amidst the pandemic. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*.

[5]. Elzainy, A., El Sadik, A., & Al Abdulmonem, W. (2020). Experience of e-learning and online assessment during the COVID-19 pandemic at the College of Medicine, Qassim University. *Journal of Taibah University Medical Sciences, 15*(6), 456–462. Doi: 10.1016/j.jtumed.2020.09.005

[6]. Yan, L., Whitelock-Wainwright, A., Guan, Q., Wen, G., Gašević, D., & Chen, G. (2021). Students' experience of online learning during the COVID-19 pandemic: A province-wide survey study. *British Journal of Educational Technology,* 2038–2057. Doi: 10.1111/bjet. 13102

[7]. Tretinjak, M. F. (2018). Moving teaching from blackboard to the learning management system—Helping absent students learn from home. In *2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, 500 -502. IEEE.

[8]. Tjong, Y., Sugandi, L., Nurshafita, A., Magdalena, Y., Evelyn, C., & Yosieto, N. (2018). User Satisfaction Factors on Learning Management Systems Usage. *2018 International Conference on Information Management and Technology (ICIMTech)*, 11-14. Jakarta, Indonesia: IEEE. Doi: 10.1109/ICIMTech.2018.8528171

[9]. Yasmin, M., & Yasmeen, A. (2021). Viability of outcome-based education in teaching English as second language to chemical engineering learners. *Education for Chemical Engineers,* 100-106. Doi: 10.1016/j.ece.2021.04.005

[10]. Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry, 11*(4), 227–268. Doi:10.1207/S15327965PLI1104_01

[11]. Chaw L. Y., Tang C. M. (2018). What Makes Learning Management Systems Effective for Learning?. *Journal of Educational Technology Systems. 47*(2) ,152–169.

[12]. Unal, Z., & Unal, A. (2014). Investigating and Comparing User Experiences of Course Management Systems: BlackBoard vs. Moodle. *Journal of Interactive Learning Research, 25*(1), 101-123.

[13]. Aljaloud, A., Uliyan, D., Alkhalil, A., & Elrhman, M. (2022). A Deep Learning Model to Predict Student Learning Outcomes in LMS Using CNN and LSTM. *IEEE Access*, 85255-85265. IEEE. Doi: 10.1109/ACCESS. 2022.3196784

[14]. Conijn, R., Snijders, C., Kleingeld, A., & Matzat, U. (2017). Predicting Student Performance from LMS Data: A Comparison of 17 Blended Courses Using Moodle LMS. *IEEE Transactions on Learning Technologies,* 17-29. Doi: 10.1109/TLT.2016.2616312

[15]. Mubeen, T., Hussain, S.K., & Aqeel, F. (2019). TALEM(The Advanced Learning and Education Management) System With OBE(Outcome-based Education). *2019 International Conference on Information Science and Communication Technology (ICISCT),* 1-5.

[16]. Akhtar, M., Andleeb, Z., & Akhtar, S. (2024). Problems of Education System in Pakistan: A Critical Analysis and Solution. *Pakistan Social Sciences Review, 8*(2), 200–210. Doi: 10.35484/pssr.2024(8-II)17

[17]. Mokhtar, S. A., Puteh, S., & Anuar, S. M. S. (2014). OBE Measurement System in Malaysian Institute of Information Technology Universiti Kuala Lumpur. In *2014 5th International Conference on Intelligent Systems, Modelling and Simulation*, 12-17. IEEE.

[18]. Harden, JR Crosby, MH Davis, M. Friedman, R. M. (1999). AMEE Guide No. 14: Outcome-based education: Part 5-From competency to meta-competency: a model for the specification of learning outcomes. *Medical teacher*, *21*(6), 546-552. Doi: 10.1080/01421599978951

[19]. Kamal, M. M., & Latip, H. H. M. F. (2009). Examinable course assessment tool based on outcome based education. In *2009 International Conference on Engineering Education (ICEED)*, 177-182. IEEE. Doi: 10.1109/ICEED.2009.5490590.

[20]. Lee, Y. K., Rahim, A. A. A., Thamrin, N. M., Nor'aini, A. J., Alias, N. M. A., & Omar, N. (2009, December). An Outcome Based approach to delivery and assessment of a course in Control System Design. In *2009 International Conference on Engineering Education (ICEED)*, 167-172. IEEE. Doi: 10.1109/ICEED.2009.5490592.

[21]. Deci, E. L., Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York.

[22]. Deci, E. L., & Ryan, R. M. (2000). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227-268. Doi: 10.1207/S15327965PLI1104_01

[23]. Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. Doi: 10.1037/0003-066X.55.1.68

[24]. Curren, R., Barber, Z., & Ryan, R. M. (2022). Moral character education after COVID-19: An Interview. *Philosophical Inquiry in Education*, *29*(1), 59-64.

[25]. Behzadnia, B., Alizadeh, E., Haerens, L., & Aghdasi, M. T. (2022). Changes in students' goal pursuits and motivational regulations toward healthy behaviors during the pandemic: A Self-Determination Theory perspective. *Psychology of Sport and Exercise, 59,* 1–10. Doi: 10.1016/j.psychsport.2021.102131

[26]. Spady, W.D. (1994) *Outcome-Based Education: Critical Issues and Answers.* American Association of School Administrators, Arlington.

[27]. Olivier, C. (1999). *How to educate and train outcomes-based*. JL van Schaik.

[28]. Dargham, J. A., Chekima, A., Omatu, S., & Chin, R. K. Y. (2012). Linking program outcomes to the courses outcomes: A top-down approach. In *2012 4th International Congress on Engineering Education*, 1-3. IEEE. Doi: 10.1109/ICEED.2012. 6779268.

[29]. Spady, W. G., & Marshall, K. J. (1991). Beyond Traditional Outcome-Based Education. *Educational leadership*, *49*(2), 67-72.

[30]. Deng, Z. T., Rojas-Oviedo, R., & Qian, X. (2002). Developing assessment tools for outcome based engineering courses. In *Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition, American Society for Engineering Education*.

[31]. Makinda, J., Bolong, N., Gungat, L., & Sarman, A. (2011). Assessment of program educational objectives using alumni survey: The UMS experience. In *2011 3rd International Congress on Engineering Education (ICEED)*, 14-17. IEEE. Doi: 10.1109/ICEED.2011.6235351

[32]. Au, O., & Kwan, R. (2009). Experience on outcome-based teaching and learning. In *Hybrid Learning and Education: Second International Conference, ICHL 2009, Macau, China, August 25-27, 2009. Proceedings 2*, 133-139. Springer Berlin Heidelberg. Doi: 10.1007/978-3-642-03697-2_13

[33]. Bagban, T. I., Patil, S. R., Ga , A., & Shirgave, S. K. (2017). On Selection of Assessment Methods in Outcome Based Education. *Journal of Engineering Education Transformations,* 327-332. Doi: 10.16920/jeet/2017/v30i3/110610

[34]. Bonk, C. J. (2004). The perfect e-storm: Emerging technology, enormous learner demand, enhanced pedagogy, and erased budgets. *The Observatory on Borderless Higher Education*, *15*(2), 1-33.

[35]. Rahman, A., Siddiqui, M., Khan, R., & Al Hassan, A. (2018). Outcome Based Education (OBE) Tools: Learning Management Systems*. International Journal of Creative Research Thoughts, 6*(2).

[36]. Nauta, M. M. (2010). The development, evolution, and status of Holland's theory of vocational personalities: Reflections and future directions for counseling psychology. *Journal of Counseling Psychology, 57*(1), 11–22. Doi: 10.1037/a0018213

[37]. Ackerman, P. L., & Heggestad, E. D. (1997). Intelligence, personality, and interests: evidence for overlapping traits. *Psychological bulletin*, *121*(2), 219. Doi: 10.1037/0033-2909.121.2.219 .

[38]. Gottfredson, G. D., & Johnstun, M. L. (2009). John Holland's contributions: A theory-ridden approach to career assistance. *The career development quarterly*, *58*(2), 99-107. Doi: 10.1002/j.2161-0045.2009.tb00050.x.

[39]. Bolles, R. N. (2019). *What Color Is Your Parachute? 2020: A Practical Manual for Job-Hunters and Career-Changers.* Berkeley, California.

[40]. Mohd Kasim, N. N., & Khalid, F. (2016). Choosing the Right Learning Management System (LMS) for the Higher Education Institution Context: A Systematic Review. *International Journal of Emerging Technologies in Learning (iJET), 11*(06), pp. 55–61. Doi: 10.3991/ijet.v11i06.5644

[41]. Krašna, M., & Pesek, I. (2020, September). Influence of Moodle and MS Teams on teaching-learning-studying (TLS) processes. In *2020 43rd international convention on information, communication and electronic technology (MIPRO)*, 612-616. IEEE. Doi: 10.23919/ MIPRO48935.2020.9245356.

[42]. Ed Tech. (2018). *6th Annual LMS Data Update*. Edutechnica. Retrieved from: https://edutechnica.com/2018/10/06/6th-annual-lms-data-update/ [accessed: 06 March 2024].

[43]. Ng, K. K., Yeung, D., Rivera, H. V., & Lee, K. Y. (2019). A Study on the eLearning Mode Via Canvas in the Non-Local Courses Registry (NCR) Programmes of a UK University in Hong Kong. In *2019 International Symposium on Educational Technology (ISET)*, 49-53. IEEE.

[44]. Phahlane, M. M., & Kekwaletswe, R. M. (2013). Contextualised framework for an inclusive learning management system in an open and distance learning environment. In *2013 Pan African International Conference on Information Science, Computing and Telecommunications (PACT)*, 34-38. IEEE. Doi: 10.1109/SCAT.2013.7055086.

[45]. Ahmed, S. (2013, May). The Role of e-Learning to Face the Challenges of the Century. In *2013 Fourth International Conference on e-Learning" Best Practices in Management, Design and Development of e-Courses: Standards of Excellence and Creativity"*, 275-275. IEEE. Doi: 10.1109/ECONF.2013.82.

[46]. Chelly, M., & Mataillet, H. (2012). Social Media and the impact on education: Social media and home education. In *2012 International Conference on e-Learning and e-Technologies in Education (ICEEE)*, 236-239. IEEE. Doi: 10.1109/ICeLeTE. 2012.6333388.

[47]. Silius, K., Kailanto, M., & Tervakari, A. M. (2011, April). Evaluating the quality of social media in an educational context. In *2011 IEEE global engineering education conference (EDUCON)*, 505-510. IEEE. Doi: 10.1109/EDUCON.2011.5773183.

[48]. Barona, C. B., & Ramirez, M. R. (2021). Effects of COVID 19 lockdown on the use of LMS platforms for virtual education. In *2021 16th Iberian Conference on Information Systems and Technologies (CISTI)*, 1-6. IEEE. Chaves, Portugal: IEEE. Doi: 10.23919/CISTI52073.2021.9476645

[49]. Sefidanoski, A., Halili, F., Velkovska, B. R., & Kaević, Z. (2022). Automated Classification of Fish Using Machine Learning and Pattern Recognition. *SAR Journal (2619-9955)*, *5*(2).

[50]. Campbell, J. P., DeBlois, P. B., & Oblinger, D. G. (2007). Academic analytics: A new tool for a new era. *EDUCAUSE review*, *42*(4), 40.

[51]. Aljaloud, A. S. et al. (2022). A deep learning model to predict Student learning outcomes in LMS using CNN and LSTM. *IEEE Access*, *10*, 85255-85265. Doi: 10.1109/ACCESS.2022.3196784.

[52]. Aldiab, A., Chowdhury, H., Kootsookos, A., Alam, F., & Allhibi, H. (2019). Utilization of Learning Management Systems (LMSs) in higher education system: A case review for Saudi Arabia. *Energy Procedia*, *160*, 731-737. Doi: 10.1016/j.egypro.2019.02.186

[53]. Alavi, M., & Leidner, D. E. (2001). Research commentary: Technology-mediated learning—A call for greater depth and breadth of research. *Information systems research*, *12*(1), 1-10.

[54]. Ariffin, N. H. M., Abd Rahman, H., Alias, N. A., & Sardi, J. (2014). A survey on factors affecting the utilization of a Learning Management System in a Malaysian higher education. In *2014 IEEE Conference on e-Learning, e-Management and e-Services (IC3e)*, 82-87. IEEE. Doi: 10.1109/IC3e.2014.7081246.

[55]. Tjong, Y., Sugandi, L., Nurshafita, A., Magdalena, Y., Evelyn, C., & Yosieto, N. S. (2018). User satisfaction factors on learning management systems usage. In *2018 International Conference on Information Management and Technology (ICIMTech)*, 11-14. IEEE. Doi: 10.1109/ICIMTech.2018.8528171.

[56]. Gottfredson, G. D., & Johnstun, M. L. (2009). John Holland's contributions: A theory-ridden approach to career assistance. *The career development quarterly*, *58*(2), 99-107. Doi: 10.1002/j.2161-0045.2009.tb00050.x.

[57]. Maldonado, L. G., Kim, K., & Threeton, M. D. (2021). An application of holland's theory to career interests and selected careers of automotive technology students. *Journal of Career and Technical Education*, *35*(1).