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EXPLORING KEY INFORMATION REQUIREMENT FOR EFFECTIVE MONITORING OF COURSES AND STUDENT PERFORMANCE: A QUALITATIVE THEMATIC ANALYSIS

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ABSTRACT

Universities serve multiple stakeholders, including students, lecturers, parents, alumni, and regulatory bodies. Among these, students stand out as a primary focus, aligning with the university's core mission to educate. Achieving stakeholder satisfaction necessitates enhanced education quality, encompassing teaching methods, program delivery, and the relevance of course offerings. Students' success in gaining knowledge, skills, and competencies is critical to university effectiveness. In today's dynamic educational landscape, digital technologies offer new avenues to enrich learning, with Learning Analytics (LA) emerging as a transformative field. The growth of big data has increased the volume and complexity of available educational data, requiring LA systems to evolve accordingly. With the universities maintaining more than one e-learning platform, LA presents a new challenge in integrating this heterogeneous e-learning data. To overcome this problem, graph databases and Resource Description Framework (RDF) ontologies have proven valuable for managing and analysing such extensive data. However, to build Web Ontology Language (OWL) frameworks that effectively support LA, researchers must first identify faculty administrators' and lecturers' specific data needs or key information, ensuring only essential information is taken to be integrated in LA. To gather the key information, interview sessions were conducted with six participants from two institutions, including an e-learning coordinator, lecturers, and faculty administrators as part of the case study. The interview result is crucial for identifying the essential information needed in LA pertaining to course performance and student performance.

Keywords: *Learning Analytics, Student Performance, Course Performance, Information Data Retrieval, e-learning,* Heterogeneous *Data Retrieval*

1. INTRODUCTION

The genesis of Learning Analytics (LA) at the intersection of data science, educational theory, and information technology. LA utilises extensive data collected from educational activities to provide important insights into student behaviours, learning patterns, and educational outcomes. This data-centric strategy enables educators to make well-informed decisions, tailor learning experiences, and ultimately enhance educational efficacy as to improve the quality of education [1] as well as achieve stakeholder satisfaction. LA's aims are to gain a thorough understanding of students' learning processes, identify grey areas, and use data-driven decision-making to optimise learning experience by utilising data that researchers have analysed [2]. A study [3] demonstrated that monitoring learning progress and assessing students' performance can be beneficial for educators and researchers in modern educational systems, especially in e-learning environments where educators acknowledge

students' patterns and subsequently, improve the curriculum and teaching standards. Additionally, the system can interact with students who are not performing well by using tactics like dialogue prompts or educational materials to improve their learning effectiveness.

In some recent LA studies [4], [5], the LA information can help faculty coordinators and head of departments to manage the resource allocation, overcome critical issue, management and arrangement of staff as well as increase efficiency in an educational institution. Faculty administrator can utilise the LA information to assess faculty performance by determining the number of experts present and available in the institutions, as well as their areas of competence [4]. In a couple of studies [6], [7] not only the LA is used to identify lecturers and their domain expertise, but also manipulate the RDF ontologies to trace lecturers' publication history. Additionally, based on the trend in academic performance, the analytics data can help faculty administration determine which topic has the highest failure rate. As a result, the faculty administrator can use it to efficiently plan the best course of action for handling any issues that may arise.

LA information can also be used by lecturers to monitor their students' performance. For example, lecturers can use the ongoing assessment data to determine which students are problematic and require extra attention from them. This method allows them to focus more on one troublesome student [8] in the long run, thus, lowering the classroom failure rate. For novice lecturers assigned to teach a new course, having access to previous assessment data can assist them in preparing teaching materials in advance by reviewing the previous evaluation criteria and activities. Class attendance and participation, including online forums, can also be utilised to track student performance. This is supported according to the LA results obtained by a study [9], showing that there is a positive correlation between the level of student participation in lesson activities and their academic performance.

According to the findings in the literature review related to Higher Education Institutions (HEIs) ontology, it is observed that most of the existing HEI ontology is related to three objectives. The first category of the ontologies is created to hold the information related to academic information, including curriculum structure, course content, and assessment. Secondly, there are also some existing ontologies that are used to support the integration and sharing of data related to institution/faculty research expertise, publication records, and projects. Thirdly, there is a category of ontologies designed to monitor student performance; however, the number of ontologies in this category is insufficient, and there is a lack of clear criteria regarding the information needed by lecturers and faculty administrators to effectively monitor student performance and the courses offered by the institution. This research aims to establish whether there could be other sources of new key information for the purposes of monitoring course and student performance through the analysis of the interview sessions, and then compare it with the key information used in other studies. The findings were themed and utilised to formulate the common questions used to generate the SPARQL queries for graph-based data retrieval and potentially to create a new ontology under this domain. In addition, the interview conducted also involved experts from Institution A and Institution B. Institution A was chosen to represent the comprehensive institution, whereas, Institution B to represent the focused university. This is to ensure that the essential data collected to track student performance and course is generated in both institution modes.
Nonetheless, clear criteria about the information

The following sections of this paper are structured as follows: Section 1 gives the background on the application of LA and how LA is being used in some of the LA studies. Section 2 identifies a literature review of some of the important information and motivation that is available and being practiced in the LA studies. Section 3 explains the approach used in the study and the research question of the study; Section 4 explains the data collection used in the study. Section 5 addresses the implication of the study while section 6 provides the conclusion of the study.

2. LITERATURE REVIEW

Graph databases and their ontologies are known as one of the common tools used to support the LA. Among the existing HEIs ontologies, a few notable ones, such as AIISO [10], Bologna [11], CCSO [12], CURUNTO [13], and OLOUD [14], are commonly referenced and utilised. These ontologies primarily focus on managing academic-related information, including curriculum structure, course content, SOW, and assessment for the courses that are available. In addition, there are HEIs' ontologies (HERO [15] and FOAF Academic [16]) that are designed to build structured knowledge bases that

represent various aspects of educational information and promote interoperability between systems. These ontologies facilitate the integration and exchange of data concerning faculty research expertise, publication histories, and project experience across various platforms. Through the literature review findings, there are two existing HEIs' ontologies that can be used to monitor student performance based on the ongoing assessment data and historical pass semester data, named MOOC [8] and OOA [17]. Hence, this study is conducted to find out if there is other key information that can be added/enriched to be used in LA studies.

When monitoring student performance, it is essential for lecturers and faculty coordinators to determine the specific information required that will serve as the main indication for student monitoring procedure. Accurate and valuable information is required for lecturers to effectively address and identify primary issues of students. Conducting regular evaluations and acquiring examples of student work are techniques deemed effective for collecting valuable data on student performance. These data are valuable for assessing the growth of individual students across several learning domains and tracking their academic accomplishments throughout the students' study period. A prevalent method employed in numerous research to evaluate student performance is by closely monitoring students' continuous assessment progress including tests, quizzes and assignments. Faculty and lecturers can closely identify students who need additional attention by knowing their ongoing progress [18]. Based on learning activities, instructors can use the data to compare student performance and create academic predictions about performance [19]. By using it, the instructor can identify students who require the greatest help and have lower ongoing assessments. As a result, prior to the final exam, instructors can focus their attention on these pupils who are having difficulty [8]. In the context of LA, this enables instructors and lecturers to provide a wide range of performance reports for students, including achievement and progress reports [20]. This is demonstrated by a number of studies that use the dashboard as a tool for tracking student performance, such as [19], [21], [22]. These studies include business intelligence (BI) and graph database studies, and they use continuous assessment as a key metric for tracking student performance.

Every student who is enrolled under a faculty is expected to be monitored by the faculty administrators, who have a more enhanced regularity. These students can be monitored in groups to help them see the bigger picture [23]. By having a group-level analysis, the faculty administrator can easily assess the performance of various groups to identify which groups are excelling or struggling. Moreover, course performance monitoring can streamline administrative processes. It allows for the aggregation of data across multiple courses and programs, enabling administrators to make informed decisions regarding resource allocation, faculty development, and curriculum design. This holistic view contrasts with student performance monitoring, which often focuses narrowly on individual student outcomes without considering the broader context of course effectiveness [24].

Lecturers are always most concerned with student behavior because it is one of the primary issues that can lower student performance. A study [25] identified several characteristics that can be used as indicators for monitoring student performance. These indicators include class attendance, Cumulative Grade Point Average (CGPA), and student involvement in activities such as community service. This is supported by a study [26] whereby there is a significant relationship between student attendance and academic performance in which the percentage of students who have high attendance rate and average academic value in each course is carried out. This is further supported by a study [27] which asserted that several recent research have discovered a positive association between class attendance and academic achievement. Hence, student attendance is essential to be monitored by lecturers for student academic success [21].

However, students' level of commitment is not simply determined by attendance. Active involvement and participation of students in classroom sessions are equally significant. Participation in this context refers to the submission of each student's assessment, which includes the number of quizzes taken, attendance, and assignments submitted [21]. Additionally, the frequency of meetings with lecturers was also taken into account and recorded as an engagement. Student participation and engagement are also important in the context of teaching and learning. If a student is not attracted to the course taught, there is a potential that the academic performance of the student will be affected. This situation is more critical, especially for online learning methods like Massive Open Online

Courses (MOOC) that depend solely on the students' willingness to learn and complete the course.

By monitoring student engagement during a lecture session, student concentration level toward the teaching and learning process can be identified. If a lecturer notices low level of concentration and participation, he or she can attempt to modify his or her teaching approach to regain the students' attention to and make the session more engaging. This technique prevents students from experiencing passivity and boredom in the classroom and transforms them into learners who engage in deep, proficient, critical, and creative thinking [28].

Another indicator that can be employed to measure student achievement is the Grade Point Average (GPA). According to [29], a comprehensive review of the recent student performance study shows that almost 70% of research focus on predicting student performance by utilising student grades and GPAs. In developing monitoring application, GPA is utilised as one of the indicators [25]. Student academic progress will be determined by consistently achieving a higher GPA for each semester. If a student obtains a low GPA, it signifies that the student is currently encountering difficulties in his or her academic pursuits.

3. RESEARCH METHODOLOGY

To generate a wider range of academic performance reports, the study categorised student academic performance into two distinct categories: course performance and student performance. The study utilised a qualitative approach to solve the research gaps. This approach allows researchers to evaluate the complex phenomena being investigated within their specific context, as stated by [30]. The objectives of the study were:

RO1) To identify the information required in monitoring the course performance.
RO2) To identify the information required in monitoring the student performance.

A phenomenological qualitative analysis method was employed to study the focus group consisting of faculty administrators (faculty head of department or program coordinator) and lecturers from two selected institutions. As supported by [31] the phenomenological methods are appropriate for investigating and explaining the experiences of individuals in the field of education. This approach entails conducting detailed interviews, selecting important statements, and grouping these statements into themes.

3.1. Selection of cases

In collecting data from the focus group, a purposive sampling was utilised. Purposive sampling technique or judgement sampling is a non-random selection technique that grant researchers to choose the most representative or helpful individual to approach [32]. It is a technique typically used in qualitative research to identify and select the information-rich cases for the most proper utilisation of available limited resources [33]. In addition, according to [34], the technique also includes identifying and selecting individuals or groups of individuals who are highly knowledgeable or experienced with the phenomenon of interest. To gather the data, two types of representatives were chosen from two selected Institutions (Institution A and Institution B). Specifically, the sample criteria were as follows: (i) faculty administrator (faculty head of department or program coordinator) that has experience for at least 1 year in managing the faculty program; (ii) lecturers that have teaching experience for more than 3 years; and (iii) e-learning coordinator that has experience in managing the student performance learning management system (LMS). E-learning coordinators were included in the focus group since this study focused on the domain of LA that involves integrating numerous student performance in LMS and SIS platforms; therefore, their feedback is essential for the technical part of the data extraction.

3.2. Data collection

Two sets of interview questions were established to suit the study objectives: to identify the information required to monitor course performance and student performance. All the experts involved in the interview were lecturers with at least 2 years of teaching experience. The selected professionals, who include lecturers and faculty administrators, are tasked with teaching multimedia to degree students at both universities in order to ensure an equitable outcome. Each interview and discussion in this research lasted around 15 to 30 minutes. The sessions were recorded with permission from the participants, and the researchers transcribed the data immediately thereafter.

Table 1: Interview respondents

Set	Theme	Expert level	Expert code	Teaching practice
1	Course Performance Monitoring	Head of Department from Institution A	Expert 1	15 years
		Program Coordinator from Institution B	Expert 2	22 years
		E-learning expert from Institution A	Expert 3	15 years
		E-learning expert from Institution B	Expert 4	4 years
2	Student Performance Monitoring	Head of Department from Institution A	Expert 1	15 years
		Program Coordinator from Institution B	Expert 2	22 years
		E-learning expert from Institution A	Expert 3	15 years
		E-learning expert from Institution B	Expert 4	4 years
		E-learning expert from Institution A	Expert 3	15 years
		E-learning expert from Institution B	Expert 4	4 years
		Multimedia Lecturer from Institution A	Expert 5	22 years
		Multimedia Lecturer from Institution B	Expert 6	8 years

Experts 5 and 6 were excluded from the course performance monitoring interview sessions, as this monitoring was relevant for faculty administrators, which concentrates on evaluating the performance of all courses provided by the institution during the semester. In contrast to monitoring student performance, it is more precise to delineate the specifics of each assessment for every student within the group under lecturers' supervision.

3.3. Data analysis

This study used a thematic analysis technique to examine interconnected subjects from people's ideas and opinions into themes [35], [36]. It offers flexibility in exploring study patterns using inductive analysis, where researchers collected the interview data and made hypotheses based on their observations. The results derived from this process, using inductive reasoning, are likely to be true [36]. Thematic analysis refers to processes that allow researchers to uncover and arrange key and significant themes and subthemes, which may then be used as units of analysis.

This thematic analysis study was carried out in six stages, beginning with the transcription of each interviewee's audio tape. Firstly, the researchers read the transcript to identify information that matched the study objectives. Then, each of the information would be assigned a code [37]. Themes or categories are components of data or words that can function as a concise and precise representation of the indicators described by individuals interviewed about the phenomena being studied. These themes comprise encoded material that has been gathered based on equations or patterns [38].

After analysing the phenomenon, the third stage required a thorough analysis before moving to the fourth stage. While the fourth stage was recognised as unique and dependent on the third, researchers had prior thematic analysis experience and undertook both stages simultaneously. Moving on to the fifth stage, the theme and subthemes were generated and thoroughly reviewed. A unique name was given to each of the themes generated. To check the hierarchical relationship and that terms provided at both levels match code meanings, the theme matrix must be extensively analysed to determine the validity of the hierarchical connection and verify that the terms presented at both stages corresponded to the meanings suggested by the codes [39]. The sixth stage was a checking stage, where in-depth discussions were presented [40].

4. RESULT

The interview results were evaluated through thematic analysis to identify patterns of the collected data. The results of this study were categorized into two themes aligned to the research objectives. The same theme category was used to group those important details with similar data categories.

4.1. RO1 result for theme 1: Course performance monitoring

The data revealed that only one (i) category emerged from the data analysis for theme 1. Figure 1 illustrates the distribution of information categorised under the theme.

Category 1: Student performance and grades

A phenomenological qualitative analysis method was employed to study the focus group consisting of faculty administrators (faculty head of department or program coordinator) and lecturers from two selected institutions. As supported by [31] the phenomenological methods are appropriate for investigating and explaining the experiences of individuals in the field of education. This approach entails conducting detailed interviews, selecting important statements, and grouping these statements into themes.

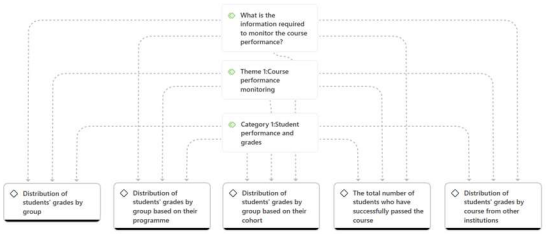


Figure 1: The distribution of theme for RO1 (Student performance and grades)

Under this theme, the faculty administrator and e-learning coordinator were required to have the distribution of the grades from each course offered in the semester. Having the course distribution information can assist the faculty administrators in identifying patterns, such as courses with unusually high failure rates or consistently high grades. This can indicate issues with the course difficulty, assessment alignment, or student preparedness, enabling targeted interventions. In addition, the faculty administrators can also use the data to identify the problematic course and group from the grade distribution records and compare the course performance results with those of the previous semester to determine whether the course performance is improving or not.

The participants stated:
"... In the context of course performance, the administration typically prioritises the distribution of grades among the available groups for the course or subject. Furthermore, it would be advantageous for me to be informed of the lecturer who instructs the group. I will be aware of the lecturer to whom I can refer in the event of an issue." (Expert 2)

This information on grade distribution is also needed by Experts 1, 2, and 4 during the interview sessions. In addition, some experts (Expert 1, Expert 2, Expert 3, and Expert 4) also need the grade distribution to be categorised by the cohort and program to add more variety of data interpretation to the course performance distribution.

The participants stated:
"... Every cohort of students can differ significantly in terms of background, abilities, and learning styles, and knowing this information helps educators tailor their teaching strategies to address those specific needs. ... by examining how a cohort performs in a particular course, the course coordinator can identify patterns of strengths and weaknesses within the group. ..." (Expert 3)

Sometimes, students in the program have a good grasp of the courses that are related to their program of study. For instance, for multimedia programs, students will often score highly in courses related to multimedia as compared to students from other computer science programs. Likewise, an artificial intelligence student is better positioned to perform in a programming subject than in other programs.

The participant stated:
"Another example is when students major on a specific field, they tend to excel in their focused subjects compared to students in other programs who are enrolled in the same subjects." (Expert 2)

In some cases, the performance of the first intake students is somehow slightly better compared to the second intake students.

The participant stated:
"One of the reasons for this occurrence is that students from the second intake do not meet the standards for advanced mathematics in the high school for admission." (Expert 2)

If the cohort and program performance differ from the norm performance, it typically indicates that an issue is affecting the students in the current semester. This should trigger the faculty administrators to investigate the cause that might affect the entire cohort or program.

A report can also be generated from the grade distribution, including the number of students who pass and fail in each group for every faculty course. By examining the passing and failure rates, the faculty administrators and lecturers will be able to determine whether the course content, teaching methods, and assessment strategies are effective. High failure rates may indicate issues with course difficulty, misalignment between teaching and assessment, or the need for additional instructional support. This information is strongly supported and needed by Expert 1.

Lastly is a comparison between students' course results and other students' of other universities. According to Experts 1 and 3, having the capacity for the LA to compare results across institutions will offer value. Such information is helpful when determining the student academic performance and therefore useful in setting the standard for each academic level. It can assist in adjusting the degree of difficulty of the courses and the grading guidelines to be consistent with the rest of the academic community, hence increasing the programs' legitimacy, Additionally, universities have the ability to compare students' academic achievement in a particular subject to that of students' from other institutions.

The participant stated:
"...I think it would be excellent if we could present the rate from either public or private colleges that provide nearly identical courses. With this information, I may compare my student's performance to other institutions." (Expert 1)

The participant stated:
" It can help faculty administrators determine how well our students are performing in comparison to their peers at other institutions, particularly when it comes to preparing them for the job market..." (Expert 3)

These are some of the key information that domain experts think should be included in any LA study pertaining to course performance, which will provide valuable insights for faculty administration regarding student course performance.

4.2. RO2 result for theme 2: Student performance monitoring

Temporarily, four categories of the group emerged through the finding of RO2, namely: (i) student performance data, (ii) at-risk students, (iii) student engagement, and (iv) CGPA. Figure 2(a) below illustrates the distribution of the key information identified under category 1 of the RO2; meanwhile, Figures 2(b), 2(c), and 2(d) illustrate the distribution of the key information for Categories 2, 3, and 4.

Category 1: Student performance data

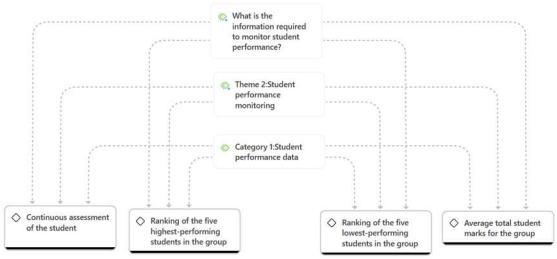


Figure 2(a): The distribution of theme for RO2 (Student performance data)

Under this theme, the faculty administrator, e-learning coordinator, and lecturers were required to have the details of the information regarding their student continuous assessment throughout the semester. Through it, the lecturers were able to see their student's performance closely with each assessment done. According to experts, this method was deemed the most effective in monitoring student performance. As early as the first or second assessment, lecturers can identify if a student is encountering academic difficulties.

The participant stated:

"...I would require the information of the ongoing assessment mark. This information is important for me to see the pattern of my student performance either they are doing well or else..." (Expert 5)

During the interview sessions, all of the domain experts (Expert 1, Expert 2, Expert 3, Expert 4, Expert 5, and Expert 6) require the students' constant information. After the semester was over, the participant would like to know the average grades of the students as well as the list of the group's top and lowest performers. It allows lecturers to view average grades and the difference between the best students and the underperforming ones in their class.

The participant stated:

"...For a better student coordination, it will be much helpful if I can see the average mark .... This

information will enable me to assess the performance of my students through the semester and also can be used to identify the good student and also problematic student that need the most help." (Expert 1)

"...if I can get the average marks across group for a particular subject offer in the semester it will give value added information to make a decision." (Expert 2)

"Furthermore, I aim to assess the failure rates within each student group and identify the top 5 and bottom 5 performers in each group." (Expert 6)

With the information on the total marks of the highest-performance and the bottom-performance students, the lecturers could not only trace the gap in their student performance, but also be used to indicate whether the class or group was highly polarised (wide performance gap) or relatively homogeneous in performance (narrow gap).

Category 2: At-risk students

Meanwhile, the second category that is merged for the RO2 theme is "At-risk student". It would be beneficial if the LA could identify the students most likely to fail the course. This information was acquired during an interview session with Experts 1, 2, and 6.

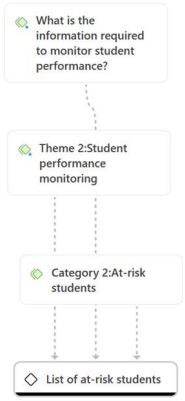


Figure 2(b): The distribution of theme for RO2 (At-risk students)

Knowing the potential students who might fail the course can provide an early warning system for lecturers. This data could be used to develop targeted interventions, such as tutoring programs, academic advising, or additional support services to help these students improve. To ensure that students can pass the course, lecturers may provide additional support, including guiding systems and mentorship, which can help reduce the number of failures during the semester [8].

The participant stated:
"...Throughout the semester, I will monitor the students' performance after the first assessment and identify those at risk of failing, defined as scoring below 50%...." (Expert 6)

In certain comprehensive institutions (conventional), the failure rate is established at 50%, however for specialised educational institutions, the passing rate is determined at 40%, particularly for Technical and Vocational Education and Training (TVET) institutions. If students do not meet the indicators, they will remain in the at-risk student list.

Category 3: Student engagement and commitment

According to several research [21], [26], [41], a student with a high percentage of lecture attendance will achieve superior marks relative to a student with lesser attendance. All the domain experts also agreed upon this during the interview. Based on their observations, they would keep a regular eye on student attendance. Students feel that they will find it difficult to learn the material if they do not attend the lectures. Attending lectures, therefore, represents student engagement and passion in addition to being important for knowledge acquisition. One of students' main responsibilities is to listen to lectures, and discipline is required.

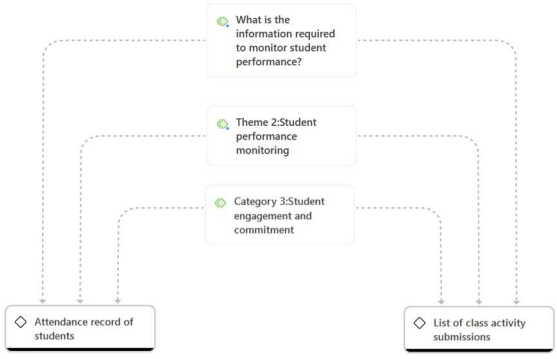


Figure 2(c): The distribution of theme for RO2 (Student engagement and commitment)

Moreover, certain dedicated instructors will review all class activities and assignments given by students to assess their comprehension.
The participant stated:
"Regarding on how to monitor the student, the first way I will monitor the student submission. .... So,

from there we also can evaluate the level of engagement and participation. Another way, I will look at the quality of the assignment and the lab activity. If the quality of the assignment is poor, it will determine their level of engagement..." (Expert 5)

"...I always monitor my student performance in their exercise, if they can perform in the exercise, then I knew that their performance is good and otherwise if their performance is not good mean that something must be done to help these problematic students." (Expert 3)

This practice can enhance students' comprehension of the content prior to the actual test and assessment. If a student encounters difficulties with the assigned activity, it will provide the lecturers an opportunity to modify their teaching approach to enhance students' comprehension.

Category 4: CGPA

Lastly, based on the interview conducted, the last information that the domain experts required and used to monitor the student's performance was based on the student's CGPA. CGPA is commonly used in Malaysia, the United States, India, and many other countries as a reflection of students' academic achievements. It is a measure used in educational institutions, especially in universities and colleges, to evaluate students' overall academic performance across all semesters or terms.

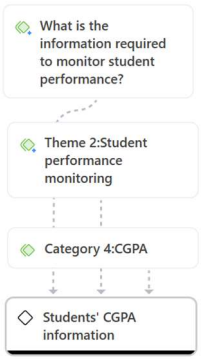


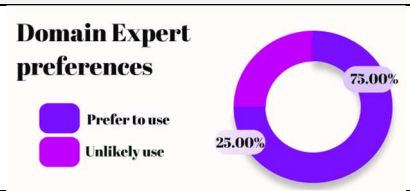
Figure 2(d): The distribution of theme for RO2 (CGPA)

The CGPA must be included in any Learning Analytics studies that concentrate on monitoring student performance, as indicated by Experts 3 and 4. It is indicated that only Experts 1, 2, and 6 possess the optimal expertise. Meanwhile, Experts 2 and 5 disagreed with its application for assessing student achievement. They believe that CGPA was overly generic and technical, preferring to evaluate student achievement through ongoing assessment.

5. DISCUSSION

In order to examine how well the interviewee conveys the important information and how frequently it is used in the current LA study to track student achievement, the study includes the interview results in Table 2 as well as a number of preceding investigations. Additionally, the table shows the percentage of frequency of how the six interviewees needed the information in the majority. While all of the data regarding course performance is new, some of the most significant data regarding student performance from the study have already been used in other studies.

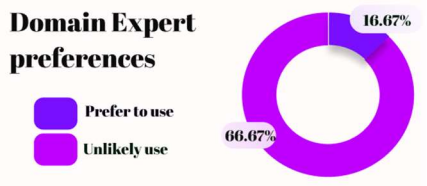
I. Table 2. Key Information that is currently being implemented by expert for course performance distribution

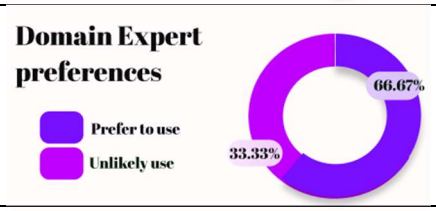
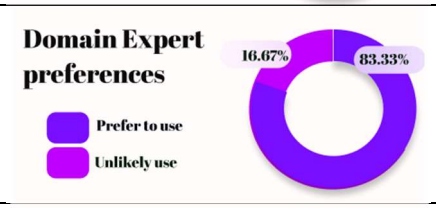
No.	Key information	Resource	Percentage utilised among the domain expert	Also existed and were used in prior research
1	Distribution of student's grades by group	Acquired during an interview session with domain Expert 1, Expert 2, and Expert 4		NA
2	Distribution of student's grades by group based on their programme	Acquired during an interview session with domain Expert 1, Expert 2, Expert 3, and Expert 4		NA

3	Distribution of student's grades by group based on their cohort	Acquired during an interview session with domain Expert 1, Expert 2, Expert 3, and Expert 4		NA
4	The total number of students who have successfully passed and failed the course	Acquired during an interview session with domain Expert 1		NA
5	Distribution of student's grades by course from other institutions	Acquired during an interview session with domain Expert 1 and Expert 3		NA

Note. Participated Interviewees: Expert 1, Expert 2, Expert 3, and Expert 4.

II. Table 3. Key Information that is currently being implemented by expert for student performance distribution

No.	Key information	Resource	Percentage utilised among the domain expert	Also existed and were used in prior research
1	Continuous assessment of the student	Acquired during an interview session with domain Expert 1, Expert 2, Expert 3, Expert 4, Expert 5, and Expert 6		[8], [19], [22], [42]
2	Ranking of the five highest-performing students in the group	Acquired during an interview session with domain expert 6		NA
3	Ranking of the five lowest-performing students in the group	Acquired during an interview session with domain expert 6		NA
4	Average total student marks for the group	Acquired during an interview session with domain Expert 1 and Expert 2		[8]

5	List of at-risk students	Acquired during an interview session with domain Expert 1, Expert 2, and Expert 6		[8], [19]
6	Attendance record of students	Acquired during an interview session with domain Expert 1, Expert 2, Expert 4, and Expert 6		[19], [21], [26], [27]
7	List of class activity submissions	Acquired during an interview session with domain Expert 1, Expert 3, Expert 4, Expert 5, and Expert 6		[21]
8	Students' CGPA information	Acquired during an interview session with domain Expert 1, Expert 2, Expert 3, Expert 4, and Expert 6		[29]

Note. Participated Interviewees: Expert 1, Expert 2, Expert 3, Expert 4, Expert 5, and Expert 6.

When processing interview information, factors that the interviewees mentioned most often can be grouped according to the agreement, which characterizes the significance of these factors. The key informations that receive 70.00 - 80.00% response are usually regarded as the consistent themes proposed by the interviewees. In the context of statistical analysis, the interpretation of correlation coefficients is pivotal for understanding the strength of relationships between variables. For this reason, an r-value of 0.7 or above is commonly regarded as indicating a strong relationship given the kind of study [43], [44] with a great extent of variance in one variable answers to different fields of Spearman or Pearson correlation coefficient. The obtained level of agreement indicates that all these factors are perceived by the respondents and are considered significant in the given context. On the other hand, there are those themes that are mentioned by more than 50.00% but less than 70.00% of the interviewees; therefore, they can be categorized as moderate. Nevertheless, these factors remain our significant variables, and their strength of association may still need to be examined more closely or alternatively cross-validated to assert their roles in this broader perspective. Lastly, factors that are less than 50.00%, cause a disagreement are not entirely valueless since a small percentage may come from special conditions or facts and with support from the respondents. However, the low level of agreement with certain themes may indicate that the concepts are exclusive to certain demographic groups or situations, making them useful tools for studying the target population.

There are four interesting key information which are observed by more than 50% of the experts in the study while monitoring the course performance. The results of this study also suggest that the best means of identifying the overall performance of a course is the use of grade distribution data irrespective of whether this is grouped under the group, programme, or cohort headings. This is agreed by all the respondents who participated: key information 1: 75.00%, key information 2: 100.00%, and key information 3: 100.00%. Besides, only 25.00% of the experts are require to see the total number of students passing and failing at the end of the semester for key information 4. However, most of the experts agree to the notion that it is unnecessary to share data on the distribution of students' grades from other institutions in their efforts to compare their students' results with those in other institutions. This is

interesting as some experts consider them as not compulsory.

On the other hand, there are 4 key information that get more than 60% experts' agreement to be used in the LA to monitor student performance. Among all the specialists, the most common use of the essential data to monitor student performance is the ongoing monitoring of their students' assessments. With it, instructors may monitor student progress as soon as the first or second evaluation is completed, and the system can notify the instructor in advance if a student is unable to understand the lecturer's methods. All respondents agreed that this approach is 100.00%, and the majority of existing studies are using it for monitoring student performance [8], [19], [22], [42].

Moreover, 83.33% of the experts recommend using the CGPA to track student performance. Together with the submission of class activities, it is also being employed in the existing study [29], and received the same score of 83.33% in the study of [21]. Finally, as suggested by 83.33% of the experts, attendance is another component of the input that is utilized to monitor students' performance and is examined in [19], [21], [26], [27].

6. CONCLUSION

The findings from the qualitative thematic analysis challenge the traditional methods suggested for monitoring student academic performance. Through the analysis, the information that is commonly used by the faculty administrators and lecturers can be categorised into two themes: course performance and student performance. The findings for both themes are presented in Tables 2 and 3. Additionally, these tables summarise the percentage of expert preferences and compare the results with existing studies that have already utilised the identified key information.

Under the course performance, it is acknowledged that the commonly advocated approach is through the distribution of grades. To be more effective, some of the faculty administrators suggest that the distribution of grades be categorised by the student cohort and program.

In contrast, when monitoring student performance, the faculty administrator and lecturers emphasize the importance of ongoing assessments, student attendance, student exercise quality, and CGPA as key indicators. The ongoing assessments, including quizzes, assignments, and class participation, provide a more granular view of student engagement and learning progress over time. These assessments offer real-time insights, allowing for timely interventions and personalized feedback, which are critical in supporting student learning journeys. Additionally, CGPA serves as a comprehensive measure that encapsulates students' overall academic performance across multiple courses, offering a holistic view rather than a single assessment point. For lecturers, integrating both ongoing assessments and CGPA data into their monitoring practices can facilitate more informed decision-making and support strategies that cater to individual student needs, ultimately enhancing the educational experience. These insights underline the importance of a multifaceted approach for performance monitoring, moving beyond traditional grade-focused evaluations to embrace a more dynamic and student-centered perspective.

For the limitation of this study, since this study collects key information through interviews with faculty administrators and lecturers, the domain experts involved are from institutions representing only comprehensive and focused institutions. It will be better if the future research study could include domain experts from research-based institutions also.

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REFERENCE:

[1] I. Degtjarjova, I. Lapiņa, and D. Freidenfelds, "Student as stakeholder: 'voice of customer' in higher education quality development," *Marketing and Management of Innovations*, vol. 2, pp. 388–398, Jul. 2018, doi: 10.21272/mmi.2018.2-30.

[2] Y. S. Mian, F. Khalid, A. W. C. Qun, and S. S. Ismail, "Learning Analytics in Education, Advantages and Issues: A Systematic Literature Review," *Creat Educ*, vol. 13, no. 09, pp. 2913–2920, 2022, doi: 10.4236/ce.2022.139183.

[3] T. Purwoningsih, H. B. Santoso, and Z. A. Hasibuan, "Data Analytics of Students' Profiles and Activities in a Full Online Learning Context." [Online]. Available: https://docs.moodle.org/38/en/Events_list_report

[4] H. Mahroeian, B. Daniel, and R. Butson, "The perceptions of the meaning and value of analytics in New Zealand higher education institutions," *International Journal of Educational Technology in Higher Education*, vol. 14, no. 1, Dec. 2017, doi: 10.1186/s41239-017-0073-y.

[5] G. Siemens, "Learning Analytics The Emergence of a Discipline," *American Behavioral Scientist*, vol. 57, pp. 1380–1400, Jun. 2013, doi: 10.1177/0002764213498851.

[6] G. Ashour, A. Al-Dubai, and I. Romdhani, "Ontology-based Course Teacher Assignment within Universities," *IJACSA) International Journal of Advanced Computer Science and Applications*, vol. 11, no. 7, p. 2020, 2020, [Online]. Available: www.ijacsa.thesai.org

[7] G. Ashour, A. Al-Dubai, I. Romdhani, and N. Aljohani, "An ontological model for courses and academic profiles representation: A case study of King Abdulaziz University," *Proceedings - 2020 International Conference Engineering Technologies and Computer Science, EnT 2020*, pp. 123–126, Jun. 2020, doi: 10.1109/EnT48576.2020.00030.

[8] S. Salam, *Unlocking Learning Patterns: MOOC Analytics and the Observatory*. UTeM Press, 2024.

[9] M. Hussain, W. Zhu, W. Zhang, and R. Abidi, "Student Engagement Predictions in an e-Learning System and Their Impact on Student Course Assessment Scores," *Comput Intell Neurosci*, vol. 2018, pp. 1–21, Jun. 2018, doi: 10.1155/2018/6347186.

[10] H. Ahuja and R. Sivakumar, "Implementation of FOAF, AIISO and DOAP ontologies for creating an academic community network using semantic frameworks," *International Journal of Electrical and Computer Engineering*, vol. 9, no. 5, pp. 4302–4310, Oct. 2019, doi: 10.11591/ijece.v9i5.pp4302-4310.

[11] B. Reinalda and E. Kulesza, "The Bologna Process – Harmonizing Europe's Higher Education," 2006. doi: 10.2307/j.ctvbkk39v.

[12] H. Kondylakis, V. Kostas, and G. Agathangelos, "Developing an Ontology for Curriculum & Syllabus," *In The Semantic Web: ESWC 2018 Satellite Events: ESWC 2018 Satellite Events, Heraklion, Crete, Greece*, pp. 55–59, 2018, [Online]. Available: www.bbc.co.uk/ontologies/curriculum

[13] M. Al-Yahya, A. Al-Faries, and R. George, "Curonto: An ontological model for curriculum representation," *Proceedings of the 18th ACM conference on Innovation and technology in computer science education*, 2013.

[14] R. Fleiner, B. Szász, and A. Micsik, "OLOUD - an ontology for linked open university data," *Acta Polytechnica Hungarica*, vol. 14, no. 4, pp. 63–82, 2017, doi: 10.12700/APH.14.4.2017.4.4.

[15] L. Zemmouchi-Ghomari and A. R. Ghomari, "Process of building reference ontology for higher education," *Conference: International Conference of Data Mining and Knowledge Engineering (ICDMKE'13)*, Jul. 2013.

[16] E. Kalemi and E. Martiri, "FOAF-Academic Ontology: A Vocabulary for the Academic Community," in *2011 Third International Conference on Intelligent Networking and Collaborative Systems*, 2011, pp. 440–445. doi: 10.1109/INCoS.2011.94.

[17] A. Nouira, L. Cheniti-Belcadhi, and R. Braham, "A Semantic Web Based Architecture for Assessment Analytics," in *2017 IEEE 29th International Conference on Tools with Artificial Intelligence (ICTAI)*, 2017, pp. 1190–1197. doi: 10.1109/ICTAI.2017.00181.

[18] A. Johari, N. Zaini, M. F. A. Latip, N. K. Madzhi, and R. A. Kassim, "Online-based continuous assessment repository for lecturers and students," in *2015 IEEE 7th International Conference on Engineering Education (ICEED)*, 2015, pp. 145–150. doi: 10.1109/ICEED.2015.7451509.

[19] M. Murad, A. Jahan, N. Sharef, H. Jalil, I. Ismail, and M. Noor, "An Analytics Dashboard for Personalised E-learning: A Preliminary Study," in *Proceedings of the 8th International Conference on Computational Science and Technology*, 2022, pp. 855–866. doi: 10.1007/978-981-16-8515-6_65.

[20] C. Li Sa, D. H. bt. Abang Ibrahim, E. Dahliana Hossain, and M. bin Hossin,

"Student performance analysis system (SPAS)," in *The 5th International Conference on Information and Communication Technology for The Muslim World (ICT4M)*, 2014, pp. 1–6. doi: 10.1109/ICT4M.2014.7020662.

[21] A. Abdul Aziz, "Intelligent System for Personalizing Students' Academic Behaviors- A Conceptual Framework," *International Journal of New Computer Architectures and their Applications (IJNCAA)*, vol. 1, pp. 138–153, Jul. 2012.

[22] M. V. das S. e S. Laécio Araujo Costa and R. J. R. A. Lais do Nascimento Salvador, "Learning analytics system for assessing students' performance quality and text mining in online communication," in *Monitoring Students Performance in E-learning based on Learning Analytics and Learning Educational Objectives*, Institute of Electrical and Electronics Engineers Inc., May 2019. doi: 10.1109/ISACV.2015.7105544.

[23] W. Y. Lan, "The Effects of Self-Monitoring on Students' Course Performance, Use of Learning Strategies, Attitude, Self-Judgment Ability, and Knowledge Representation," *The Journal of Experimental Education*, vol. 64, no. 2, pp. 101–115, 1996, doi: 10.1080/00220973.1996.9943798.

[24] A. Sbeih and O. Karram, "E-Smart System to Evaluate Faculty Members' Performance," 2014. doi: 10.1109/icwoal.2014.7009191.

[25] A. Nurmoslim, T. Hidayat, S. Khoirunnisa, T. Oktavia, and N. Limantara, "Student performance indicator monitoring systems : A case study ABC university," in *2017 International Conference on Information Management and Technology (ICIMTech)*, 2017, pp. 88–93. doi: 10.1109/ICIMTech.2017.8273517.

[26] J. Durfee, W. Loendorf, D. Richter, T. Geyer, and D. Munson, *A Formal Research Study on Correlating Student Attendance to Student Success*. 2012. doi: 10.18260/1-2--20810.

[27] S. Welsen, "Engineering Students' Engagement and Their Perspective on Compulsory Classroom Attendance," in *2022 IEEE IFEES World Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC)*, 2022, pp. 1–5. doi: 10.1109/WEEF-GEDC54384.2022.9996231.

[28] Y. A. Mohd Yusof *et al.*, "Student-Centred Approach in Medical Education: A Review of the Teaching-Learning Activities and the Perceptions of Educators on the Students Engagement and Performance at the Faculty of Medicine and Defence Health, National Defence University of Malaysia," *Advances in Human Biology*, vol. 12, no. 2, 2022, [Online]. Available: https://journals.lww.com/adhb/fulltext/2022/12020/student_centred_approach_in_medical_education__a.3.aspx

[29] T. M. N. Sagala, S. D. Permai, A. A. S. Gunawan, R. O. Barus, and C. Meriko, "Predicting Computer Science Student's Performance using Logistic Regression," in *2022 5th International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*, 2022, pp. 817–821. doi: 10.1109/ISRITI56927.2022.10052968.

[30] P. Baxter and S. Jack, "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," *Qualitative Report*, vol. 13, Jul. 2010, doi: 10.46743/2160-3715/2008.1573.

[31] M. Bevan, "A Method of Phenomenological Interviewing," *Qual Health Res*, vol. 24, pp. 136–144, Jul. 2014, doi: 10.1177/1049732313519710.

[32] H. Russell Bernard, *Research Methods in Anthropology: Qualitative and Quantitative Approaches*, vol. 4. 2006.

[33] M. Q. Patton, *Qualitative research & evaluation methods: Integrating theory and practice*. 2014.

[34] John W. Creswell and Vicki L. Plano Clark, *Designing and Conducting Mixed Methods Research*. 2011.

[35] G. Guest, E. Namey, and M. Chen, "A simple method to assess and report thematic saturation in qualitative research," *PLoS One*, vol. 15, p. e0232076, Jul. 2020, doi: 10.1371/journal.pone.0232076.

[36] N. Hayes, *Doing qualitative analysis in psychology*. Hove, England: Psychology Press/Erlbaum (UK) Taylor & Francis, 1997.

[37] V. Braun and V. Clarke, "Reflecting on reflexive thematic analysis," *Qual Res Sport Exerc Health*, vol. 11, pp. 1–9, Jul. 2019, doi: 10.1080/2159676X.2019.1628806.

[38] J. Creswell, "Qualitative Inquiry & Research Design: Choosing Among Five Approaches," *SAGE Publications*, vol. 11, Jul. 2013.

[39] V. Clarke and V. Braun, "Thematic Analysis," in *APA handbook of research methods in psychology*, vol. 3, 2014, pp. 1947–1952. doi: 10.1037/13620-004.

[40] O. Labra, C. Castro, R. Wright, and I. Chamblás, "Thematic Analysis in Social Work: A Case Study," in *Social Work Education*, 2019, pp. 183–202. doi: 10.5772/intechopen.89464.

[41] R. S. I. Wilson, J. S. Goonetillake, W. A. Indika, and A. Ginige, "A conceptual model for ontology quality assessment," *Semant Web*, vol. 14, no. 6, pp. 1051–1097, Dec. 2023, doi: 10.3233/SW-233393.

[42] A. Johari, N. Zaini, M. F. A. Latip, N. K. Madzhi, and R. A. Kassim, "Online-based continuous assessment repository for lecturers and students," in *2015 IEEE 7th International Conference on Engineering Education (ICEED)*, 2015, pp. 145–150. doi: 10.1109/ICEED.2015.7451509.

[43] I. Lorenzana *et al.*, "Relationships Among Clinical Factors and Patient-Reported Outcome Measures in Adults With Convergence Insufficiency," 2022. doi: 10.1097/opx.0000000000001929.

[44] J. Runge, "On the Graph-Theoretical Interpretation of Pearson Correlations in a Multivariate Process and a Novel Partial Correlation Measure," 2013. doi: 10.48550/arxiv.1310.5169.