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Evaluating student satisfaction with data acquired by Moodle using: A feasibility study

Bachelorarbeit

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Die Kapitel I bis III der vorliegenden Bachelorarbeit wurden im Rahmen der Lehrveranstaltung „Bachelor Seminar 1“ eingereicht und am 15.02.2024 als Bachelorarbeit 1 angenommen.

Kurzzusammenfassung: Evaluating student satisfaction with data acquired by Moodle using: A feasibility study.

Die vorgelegte Bachelorarbeit ist eine Machbarkeitsstudie, die sich auf die Bewertung der Studentenzufriedenheit unter Verwendung von Daten aus Moodle konzentriert. Sie zielt darauf ab, die Machbarkeit der Implementierung eines Systems zur Überwachung der Studentenzufriedenheit in Online-Kursen aus technischer, rechtlicher und organisatorischer Sicht zu bewerten. Es wird untersucht, ob es möglich ist, ausschließlich mithilfe von Moodle generierte Daten die Studentenzufriedenheit im Laufe eines Kurses vorherzusagen.

Ein technisches Setup mit Moodle und anderen notwendigen Werkzeugen bildet die Grundlage für diese Studie. Die Analyse konzentriert sich auf sechs Faktoren, die die Studentenzufriedenheit beeinflussen, darunter wahrgenommene Benutzerfreundlichkeit, wahrgenommener Nutzen, Informationsqualität, Systemqualität, Servicequalität und Computer-Selbsteffizienz. Während des Semesters durchgeführte Umfragen in verschiedenen Abständen helfen, Trends in der Studentenzufriedenheit zu verfolgen.

Aus rechtlicher Sicht untersucht die Studie die Einhaltung der DSGVO und anderer relevanter Vorschriften, um sicherzustellen, dass Daten ethisch korrekt behandelt werden. Organisatorisch betont die Arbeit die Bedeutung von Kommunikation und die Einbindung der Interessengruppen bei der Einrichtung und Pflege eines Systems zur Überwachung der Studentenzufriedenheit.

Schlagwörter:

Moodle, Studentenzufriedenheit, Online-Kurse, Fachhochschulen, Universitaet, Bildungsqualität, E-learning

Abstract: Evaluating student satisfaction with data acquired by Moodle using: A feasibility study.

This thesis is a feasibility study focusing on evaluating student satisfaction using data from Moodle. Its aim is to assess the feasibility of implementing a system to monitor student satisfaction in online courses from a technical, legal, and organizational perspective. It investigates whether it is possible to predict student satisfaction over the course of a class using only data generated from Moodle.

A technical setup with Moodle and other necessary tools forms the basis for this study. The analysis focuses on six factors that influence student satisfaction, including perceived ease of use, perceived usefulness, information quality, system quality, service quality, and computer self-efficacy. Surveys conducted at various intervals throughout the semester help track trends in student satisfaction.

From a legal perspective, the study examines compliance with the GDPR and other relevant regulations to ensure that data is handled ethically. Organizationally, the work emphasizes the importance of communication and stakeholder involvement in setting up and maintaining a system to monitor student satisfaction.

Keywords:

Moodle, student satisfaction, online courses, universities of applied sciences, university, education quality, e-learning

Evaluating student satisfaction with data acquired by Moodle using: A feasibility study

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Affidavit

I, Roman Sernetz, declare under oath that the bachelor thesis entitled ”Evaluating student satisfaction with data acquired by Moodle using: A feasibility study” submitted to Ferdinand Porsche FernFH is my original work. I affirm that: all ideas, concepts, and content presented in this thesis are my own, except where indicated otherwise through proper citation. All sources used in this thesis have been acknowledged and cited according to the citation style prescribed by the Ferdinand Porsche FernFH. No part of this thesis has been submitted for any other degree or qualification at this or any other institution. The research conducted for this thesis complies with the ethical standards set forth by Ferdinand Porsche FernFH. Any assistance received during the research and writing of this thesis has been duly acknowledged in the acknowledgment section. I understand that providing false information in this affidavit may result in academic penalties in accordance with the regulations of Ferdinand Porsche FernFH.

Acknowledgment

I would like to express my deepest gratitude to all those who supported me in the achievement of this bachelor's thesis. A difficult road but one which was very satisfying and for this, I say Thank you to everyone who stood by me and guided me through. First, I would like to extend my deep appreciation to my thesis supervisor FH-Prof. DI Dr. Igor Miladinovic. Your expertise, determination and motivation were priceless in each step of this research. This thesis owes its success to your sharp remarks as well as your knowledgeable comments. I want to recognize the faculty members of Ferdinand Porsche FernFH whose thought-provoking lectures gave me a solid footing in the topic. Moreover, my thanks go out also towards Prof. (FH) DI Dr. Martin Staudinger for their advice and suggestions during the course of this study. But more than that, I owe a great deal of thanks to my family. Your unfaltering support, compassion and encouragement empowered me to overcome academic hurdles. Specifically, I am grateful for the sacrifices and confidence my wife, children and parents have shown towards me. Friends and classmates - I owe you all a debt of gratitude for your presence when it was needed most – that network of connections that offered both moral support and shared learning throughout this educational journey. Lastly, I would like to extend my appreciation to all authors whose work has been cited in this research work. They have played a key role in shaping my understanding of the subject. In summary, without the combined efforts of those persons listed above, this thesis could not have been completed.

Thank you.

Ing. Roman Sernetz
Ferdinand Porsche FernFH
June 5, 2024

Contents

List of terms

ATTLS	Attitudes Towards Thinking and Learning Survey
CMS	Course Management System
COLLES	Constructivist On-Line Learning Environment Survey
CSE	Computer Self Efficacy
DPO	Data Protection Officer
FHStG	Fachhochschulgesetz
GDPR	General Data Protection Regulation
GPLv3	GNU General Public Licence v3
HEO	Higher Education Organization
ICT	Information and communications technology
IoB	Internet of Behaviour
IoT	Internet of Things
IQ	Information Quality
LCMS	Learning Content Management System
PEOU	Perceived Ease of Use
PU	Perceived Usefulness

SS	Student Satisfaction
SvQ	Service Quality
SyQ	System Quality
TAM	Technology Acceptance Model
UAS	University of Applies Science
UX	User Experience
VM	Virtual Machine

I Introduction

I-A Motivation

Frequently, the use of conventional research methods for assessing e-learning courses in Higher Education Organization (HEO) environments or online surveys leads to an average response rate of approximately 44% as shown in the research of Wu et al. [1]. However, using targeted surveys and measures, including pre-notifying the participants, can increase the response rates. Therefore, leaders in organizations face a major challenges when it comes to evaluating the quality and satisfaction of all learners participating in online courses. Besides, these surveys are usually done post-course completion limiting the inclusion of improvements on educational services until the following year's course. Better student satisfaction will enhance the experiences of learning platforms by administrators, teachers and learners in a management system. Therefore, the research objective for adoption or implementation of a system to monitor student satisfaction for online courses depends on its feasibility. In addition, as Internet of Behaviour (IoB) [2] extends and is deeply embedded into everyday life from Internet of Things (IoT) [3] perspective, it is crucial that a feasibility study incorporates; this concept [4]. This implies that the internet behaviour concept must be included in any feasibility study. The ability to automatically collect and process critical data required to determine student satisfaction helps administrators and instructors to address course satisfaction earlier than current practise allows.

I-B Goal

This thesis aims at evaluating the possibility of measuring student satisfaction by using data collected from Moodle [5]. The evaluation will consider technical, legal and operational considerations thus providing a holistic view of these domains. Moreover, the study intends to investigate the chance of evaluating satisfaction across all course participants and determine whether it is feasible to predict levels of satisfaction as a learning process during the course's duration. The study will determine if implementing this system through the IoT is feasible by critically examining whether it is possible to rely entirely on data generated by Moodle alone. Additionally, the organizational analysis will test how a potential implementation can be realized within HEO. From legal point of view, there should be regard for scrutinizing Austrian legislation against European laws.

I-C Differentiation

This scientific thesis places a primary focus on evaluating viability, with a central emphasis on delving into the technical, operational, and legal dimensions. However, it does not delve into the practical or technical implementation of such a system within any learning management platform. This study does not explore the influence of human psychology and will not include an examination of individual satisfaction levels. The investigation will exclusively concentrate on the Moodle application itself and the database instances where the data within Moodle resides. It will not incorporate any data obtained from other Internet of Things devices, such as wireless network metadata or any other third-party systems where students are interconnected with HEOs. Additionally, the economic aspect of monitoring during an online course will not be examined in this thesis.

I-D Target Audience

This bachelor thesis is designed for professionals with proficiency in business informatics, informatics, human psychology, and higher education administration, particularly those engaged in managing student satisfaction at HEOs. While the thesis will delve into the background and existing research, it assumes a foundational grasp of informatics from the reader. The assessment of organizational and technical feasibility targets an international audience. However, the examination of legal feasibility will predominantly focus on Austrian legislation aligned with European laws. It is crucial to adapt the legal considerations when applying the findings in diverse legal environments.

I-E Significance

The significance of this topic is derived from the traditional way of giving post-course surveys within e-learning. It is a measure at one point, usually after the course ends, to see how much students liked it. However, it does not record how much student satisfaction changed during the semester. Also, there is a threat that student satisfaction may be primarily affected by what happened recently as well as the role of examination outcomes on general satisfaction levels.

I-F Research question

Is it feasible, from technical, legal, and operational standpoints, to determine the satisfaction level of students by using data acquired through the Moodle learning management system?

I-G Hypothesis

Hypothesis 1 (H1): *The technical implementation of such a monitoring system is feasible, as data that is already available within Moodle and needs to be evaluated in the context of human psychology.*

Hypothesis 2 (H2): *From a legal perspective, there will be an impact on the quality of predictions, as anonymization and pseudonymity will impose restrictions on data processing.*

Hypothesis 3 (H3): *The operational implementation may not be possible for every organization, as data needs to be evaluated and contrasted with human behaviour. Not all HEOs will have the resources to provide such a service.*

II Background / Theory

II-A Moodle

In this thesis, Moodle [5] (Modular Object-Oriented Dynamic Learning Environment) in its official version 4.3 released on October 9, 2023, is used. Moodle itself is a Learning Content Management System (LCMS) operating online and, as asserted by Al-Ajlan and Zedan [6], it is developed specifically as a Course Management System (CMS) and Virtual Learning Environment with roots in educational principles. The development of Moodle began in 1999 with and the release of the first, initial version in 2002 and has been evolving ever since. Its code-base is written in PHP and operates under the GNU General Public Licence v3 (GPLv3) [7].

According to Cole and Foster [8], it is one of the most used learning management systems in Higher Education Organization (HEO)s. This popularity is due to its open-source nature, with contributions from a global community, aligning with academic values of knowledge sharing, peer review, and the concept of freedom embedded in the open-source philosophy. In addition to that, the popularity can also be attributed to its being free from licensing fees and maintenance contracts. Moodle furthermore empowers educators to manage graded assignments, lessons, and various content types. It also facilitates document sharing, quizzes, workshops, and chat functionalities. Its user-friendly interface fosters a conducive environment for learners, ensuring high-quality learning experiences. Additionally, the Moodle community provides flexibility to enhance the core system with various plugins also called activities, available on Moodle's official website cited.

For operational use Moodle requires a web server (e.g. Apache, nginx) and a database (e.g. MySQL, MariaDB, PostgreSQL) and additionally several PHP extensions and configuration items according to the software requirements.

Moodle offers a range of survey options, with the initial one being the "survey activity,"

enabling you to employ two predefined surveys. However, it lacks the capacity for customizing survey questions. The two predefined surveys available are the Constructivist On-Line Learning Environment Survey (COLLES) and Attitudes Towards Thinking and Learning Survey (ATTLS). These survey methods have undergone a thorough examination in a study by Dougiamas and Taylor [9]. Both of these approaches primarily focus on assessing the educational experience of students throughout the course, particularly concerning pedagogics, and provide educators or administrators with an automated means to assess the collected survey data. Additionally, both of these surveys allow for the inclusion of five open-ended questions, which necessitate manual evaluation by the instructor. The other built-in option for conducting a survey is to facilitate the Feedback activity in Moodle [10]. This allows the option to write the own questions, instead of using a predefined question set as described before, and supports the export of the data acquired directly from the graphical user interface. The most sophisticated module available within the Moodle ecosystem for conducting surveys is the Questionnaire activity in Moodle [11], which is currently in development by the community. This module is primarily designed for data collection and is known for its extensive customization options. It also comes with built-in support for exporting collected data into various advanced data formats that can be subsequently processed. As mentioned before the downside of using this activity in Moodle is that when a new stable Moodle version is released, a potential operation risk occurs that the community driven Questionnaire module is not compatible to the latest Moodle stable release in time. Therefore, this thesis will focus on Moodle activities which are maintained by the Moodle developer themselves.

Since its beginning, Moodle has aimed to enrich students' learning experiences through its Mobile Applications. However, using the Moodle App in HEO environments comes with specific limitations. These constraints stem from the need for administrators in Higher Education Organizations to register the Moodle platform as a statistical site. This requirement involves having a minimum of over 500 active mobile users annually or opting for a pro or premium plan for access to the App of Moodle [12].

The free plan's administrative capabilities are limited, making it more suitable for small to medium-sized HEOs. Access to the Pro and Premium Plans is available at no cost if the Moodle site is hosted by a Moodle Certified Partner or through the use of MoodleCloud. This feature significantly contributes to improving the overall user experience. However, in the current 4.3 release of Moodle, there is no internally integrated or third-party plugin available for Moodle web-service or Moodle mobile App.

Even more, Han [13] accused Moodle to have flaws in protection of student data regarding the implementation of Google Analytics. To face this accusation Moodle [14] officially declared that deficiency was not introduced by Moodle learning management system itself instead this was introduced by the institution service provider which was investigated by Human Right Watch. Moodle officially stated to this accusation: "*The report published by Human Rights Watch suggests that Moodle App collects learners' location data and uses Google Firebase Analytics. This is simply not accurate. The Moodle App does not use any user-tracking or analytics tool and only accesses user location when the user requests it for a particular reason. It doesn't track the user location at any other time.* " Additionally, "*Equally, the microphone and camera are only used when the learner requests them. For example, the learner may want to record an audio or video file and upload it to Moodle as part of an assessment. Again, the mobile operating system or Moodle App alerts the student in this instance.*"

II-B Internet of Things

Xia et al. [3] defined Internet of Things (IoT) as a situation where physical objects may have sensors, processing ability, software and so forth which can link with other similar technologies or are linked through communication networks while the most common network for IoT devices to connect to is the World Wide Web shortly called Internet. On the other hand, other communication networks have also been proposed since devices

TABLE II
FOUR STAGES OF IOT

Stage	Stage description	Purpose
1.	Data capture	Collect data from their environment.
2.	Data sharing	Data is sent to the cloud through a network connection, and IoT devices can access the data.
3.	Data processing	Processing of the data in the cloud using data analytics tool, artificial intelligence and machine learning to make data useful.
4.	User interface	Transfer the processed data to the user.

do not have to be connected to public internet e.g. microwave links can be used. In reality, however, IoT devices are able to converse among themselves and systems such as smart home systems and analyse and process the data autonomously by itself. In spite of this, the immense amount of data emanating from IoT devices does not make it possible to understand human behaviour even if it contains useful information. These aggregated data of IoT devices deliver valuable insights on user behaviour, their desires and expectations, and are able to uncover secondary information and connections between humans. According Sun et al. [15], the IoT is composed of four stages as described in Table II.

To describe these insights, the concept of Internet of Behaviour (IoB) was introduced, combining and connecting the fields of data analysis, behavioural and semantic analysis and technology using the methods and tools of human psychology.

II-C Internet of Behaviour

Internet of Behaviour (IoB), involves the way individuals behaviour themselves online. This is where data on what users do on the internet is collected and studied to understand the preferences, daily routines, and how choices are made. As such, Nyman [2], an

emeritus psychology professor at University of Helsinki who defined that term paints this picture of internet behaviour concept as:

> "*The core idea behind the Internet of Behaviour (IoB) is to provide means to personally code, register, share and address (individual or organizational) behaviours and to use pre-defined IP (v6) addresses to be used as individuals or any communities see as best.*"

Nyman proposed to that the IoB represents a novel approach to monitor behavioural patterns through the assignment of unique IoB addresses to each pattern, which can then be deciphered for purposes aligned with community preferences.

According to Sun et al. [15] the IoB is taking the same parameters as the IoT, but data is going to be processed differently. User behaviour is taken into considerations and what a specific pattern is presenting and how they affect user. Therefore, it has the ability to make conclusions from changing circumstances and make decisions based on that findings. For businesses and organizations worldwide, the Internet of Behaviour offers new insights into consumers behaviour, as Javaid et al. [16] described. Organizations and companies will be able to compare previous performance and forecast the future behaviour using data gathered by Internet of Things devices and will organize development, marketing and operation about new tools. For evaluating students satisfaction data for higher education organizations, an automated ecosystem of analytical process that track, gather and attempts to analyse the massive amount of data users create through their online activities, in the same way as was done with student surveys about their satisfaction when participating at an online course in the past. The data used in IoB is collected similarly to IoT and most of the data is based on IoT data collection and data lakes. IoB, unlike IoT, does not only collect data but also goes further by tracking transactions and geotagging activities to connect locations with specific interests, analysing browser history and cookies, monitoring social media interactions, and understanding relationships between users through various services. These collected data and insights allow consumer analysis such as purchasing practices and the interaction between users and equipment as

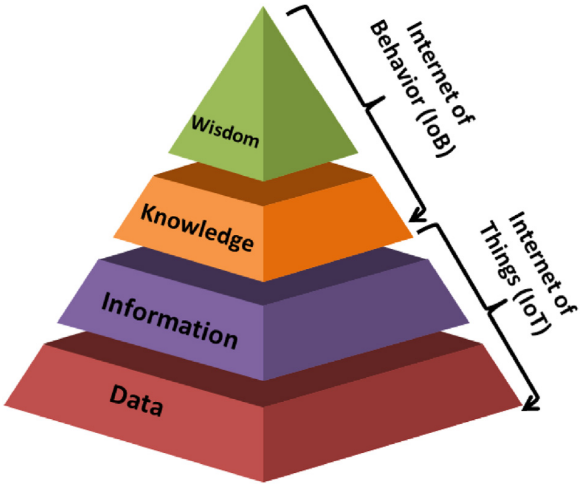

Fig. 1. Internet of Things (IoT) and Internet of Behaviour (IoB) pyramid (reprinted with permission of Embarak [4])

well as examination of goods. This enables companies to establish links based directly on the gathered consumer data to the non-consumer related data of IoT-devices using this data as knowledge-gathering hub. The evaluation of this behaviour offers a great benefit for optimizing students satisfaction level during participating online courses. In 2021, IoB was considered as one of the top tech trends, with the COVID-19 pandemic as the main driver forcing organizations and companies to rethink their business model in terms of consumers outreach and communication. IoB aims to answer how to interpret the acquired data and how to use that gained knowledge to develop and advertise new services, considering the aspects of human psychology, as shown in Fig. 1

Embarak [4] redefined the IoB as:

> "*The Internet of Things translate data to information, and the Internet of Behaviour may translate our knowledge into genuine wisdom.*"

He proposed several uses cases for mapping between IoT and IoB, see Fig. 2 and Tab. III.

Adapting the IoB concept can also change the value chain between network and people at the same time in real time. IoB systems can capture, merge and process information from different outlets such as student information, citizens information from governmental

TABLE III
MAPPING OF IOT & IOB TO ACTIONS IN SMART SYSTEMS

IoT & IoB actions	Transformation	Description
IoB Wisdom	Significant Influence	Observe and track learner behaviour: Collect Information about students inside the classroom, learning activities, their volunteering behaviours, how to react to exercises and assessments and everything else related to their academic process.
IoB Knowledge	Recognize Significant	Analyse student behaviour: Data acquired from IoT used to analyse student behaviour. This will not give automated suggestions instead it will provide information regarding learner behaviours during studying.
IoT Information	Analyse Behaviour	Recognize significance: Behavioural analysis and psychology provide insights into the data acquired by IoT. The IoB has the potential to be a helpful tool for business and organizations to understand and forecast behaviours that result.
IoT Raw Data	Track Behaviour	Important influence: HEOs can utilize the IoB mechanism to maintain an adaptive system that identifies student behaviours and recommend behavioural changes that will result in a better outcome.

systems, social media, facial recognition and similar resources to provide knowledge of consumers behavioural. Consumer-specific information is collected by organizations and companies directly, but they also gather non-specific consumer data through the interconnectedness of devices. Therefore, student satisfaction experience can be done tailored made for individuals and classes to address potential issues more precisely for

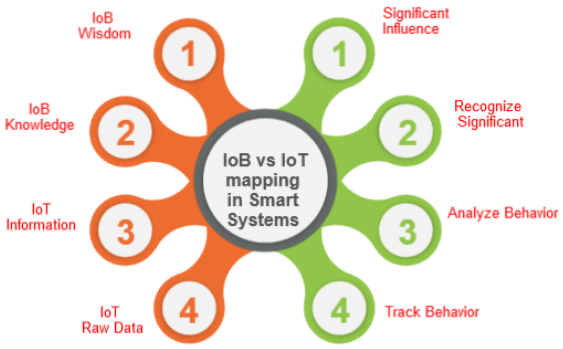

Fig. 2. Internet of Behaviour (IoB) and Internet of Things (IoT) mapping to actions (reprinted with permission of Embarak [4])

the raise of the overall student satisfaction level of a course.

For answering the hypotheses, especially [H1], IoB should be considered if its methods can contribute to evaluate students satisfaction during participation of online-courses by evaluating IoT data.

II-D Student Satisfaction

At present, Higher Education Organization (HEO)s assess student satisfaction in Moodle through its native survey tools after course completion or use external tools post-class. This timing means HEOs can only use survey results to improve future courses, missing chances to enhance current course experiences.

Various studies examine factors affecting student satisfaction in Learning Content Management System (LCMS), proposing a wide range of evaluation models. The Nguyen [17] research model, reviewed by Toring et al. [18], offers a promising solution but overlooks certain implementation and non-functional aspects of the LCMS. Alkhateeb and Abdalla [19] take a broader approach, factoring in students' computer self-efficacy when using Moodle.

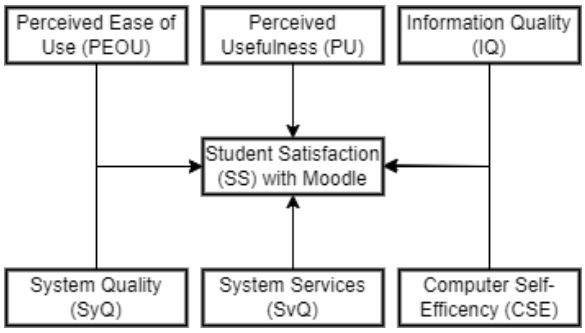

Fig. 3. Research model by Alkhateeb and Abdalla [19]

They validated their research model (refer to figure 3), identifying six key factors for evaluating student satisfaction in Moodle. The model in this study, aimed at understanding student satisfaction with the LCMS, selects six potential influencing factors based on previous literature. The study is explanatory, using a questionnaire divided into two parts for data collection. The answering possibilities were using the Likert scale [20] with a range of five, on a spectrum between strong agreement to strong disagreement. The first part gathers demographic information of the surveyed students, and the second part measures the factors relevant to the study. Cronbach's alpha coefficient [21] was used to evaluate the study's items reliability, where all coefficient values above the cut-off value of 0.7 are accepted as reliable. In addition, the research employed linear regression models for testing the proposed hypotheses.

For the analysis last step, a multiple linear regression model was used to evaluate how all these potential factors collectively and simultaneously affected student satisfaction. It could be shown that the multiple correlation coefficient of 0.800 with a determination coefficient of 0.639 were determined for the regression. Thus, indicating that there is a positive relationship between those six elements and students satisfaction with the LCMS. Hence, it can be concluded that the Pearson's R value is equal to 0.639, meaning that these predictors explain about 64% of the variability in students satisfaction. Therefore, it was proposed an alternative version of the regression equation that includes only

significant variables, which will enable to assess how these influences affect students Moodle contentment as expressed by Equation II.1.

$$SS = -0.076 + 0.124PEOU + 0.169PU + 0.154IQ + 0.266SyQ + 0.128SvQ + 0.190CSE \quad \text{(Eq. II.1)}$$

The parameters of Equation II.1 in context of Moodle can be understood as shown in Table IV and V. A closer look at the involved factors will be given in the following subsections.

For controlling the dependent variable SS given by Equation II.1 the survey of Alkhateeb and Abdalla [19] as shown in Table VI were used. Together with the six factors described before the research model could be justified and considered as reliable.

II-D1 Perceived Ease of Use (PEOU)

One of the key concept in Information and communications technology (ICT), the Perceived Ease of Use (PEOU) introduced by Davis [23], forms an integral part of the Technology Acceptance Model (TAM). The TAM was designed to understand and predict elements affecting people's adoption and acceptance of new technologies.

The PEOU, in contrast, describes how easy a user perceives of the usage of a particular ICT system or technology is going to be. According to Davis, this perception determines the users‘ attitudes and intentions towards adopting any technology. He, furthermore, adds that people tend to use technologies they perceive as simple and user-friendly.

The importance lies in the fact of understanding a technology as simple to use and its influence on user interactions. If someone thinks of a particular technology as straightforward, they expect low levels of effort and cognitive load when utilizing it. This perception enhances the likelihood for other users to accept the technology positively, too. As such,

TABLE IV
FACTORS INFLUENCING STUDENT SATISFACTION IN CONTEXT OF MOODLE BASED ON RESEARCH BY ALKHATEEB AND ABDALLA [19]

Parameter	Description
LCMS Acceptance (Perceived Ease of Use (PEOU) & Perceived Usefulness (PU))	The LCMS is a typical software that facilitates document management, reporting, tracking and the delivery of e-learning courses. To develop interactive, well-designed, user-friendly and effective systems, HEOs should take into account various factors that can impact users satisfaction with these LCMS. These factors encompass both technological aspects, such as SyQ and information content, and the human dimension represented by systems users and their willingness to embrace and utilize the technology. Perceived Ease of Use (PEOU) is defined as the extent to which student find it effortless to use the LCMS, while Perceived Usefulness (PU) represents the student's belief that using LCMS can enhance their performance. PU was discovered to have a significantly predicts students satisfaction in e-learning. PEOU on the other hand was not found to significantly influence the student's satisfaction.
Information Quality (IQ)	Any information system's main role is delivering information to its users. The system's information quality can be assessed by semantic success measures like timeliness, accuracy, completeness, consistency and relevance. This implies that higher information quality leads to a greater level of satisfaction with the system. Additionally, Student Satisfaction (SS) with LCMS usage has been continuously established as being positively and significantly influenced by Information Quality (IQ).
System Quality (SyQ)	Pertains to how well a system performs based on user perception. Quality can be assessed through organizational and individuals impact, technical success and user satisfaction. Specifically, metrics for System Quality (SyQ) encompass usability, responsiveness, availability and reliability. Numerous previous studies shown a significant connection between system quality and students satisfaction. The greater students perceive the LCMS as being available and reliable, the higher their satisfaction.

TABLE V
FACTORS INFLUENCING STUDENT SATISFACTION IN CONTEXT OF MOODLE BASED ON RESEARCH BY ALKHATEEB AND ABDALLA [19]

Parameter	Description
Service Quality (SvQ)	Initially, the construct of service was defined as "*the overall support delivered by the service provider*". However, in the present study, it pertains to the characteristics of services provided by the Information and communications technology (ICT) department at the HEO, which encompass responsiveness, availability and effectiveness. The satisfaction of students has been one topic that has been widely researched in order to determine how Service Quality (SvQ) impacts it. This has also helped in recognizing quality as a chief determinant of student satisfaction.
Computer Self Efficacy (CSE)	Has great importance within the field of behavioural studies and many other technology-based researches. It means that a person believes in their ability to do something using a computer. How much confidence a student has in using computers can greatly affect how they use the LCMS. Students who have more confidence when it comes to using computers may find it easy using them unlike those who lack confidence in their use hence may be afraid to use technology. This indicates that the level of Computer Self Efficacy (CSE) is thus connected with students' view on whether e-learning is profitable for them because this variable is an important predictor of perceived learning outcomes. Thus, this variable has been recognized as an important predictor within an LCMS.
Student Satisfaction (SS)	Satisfaction is a persons feeling of happiness or unhappiness about something, which begins with comparing what they expected to what actually happened. When it comes to e-learning, Student Satisfaction (SS) refers to the belief that the LCMS meets their information needs. Normally, students use their satisfaction level in LCMS as an indicator and if they are very satisfied, they will continue using it.

TABLE VI
SURVEY QUESTION FOR DETERMINING STUDENT SATISFACTION (SS)

No.	Student Satisfaction (SS)	Reference / Defined in
1.	I feel satisfied with the quality of information provided through my university portal.	[22]
2.	I feel satisfied with the quality of my university portal system.	[22]
3.	I feel satisfied with the educational services provided through the university portal.	[22]
4.	I advise my colleagues to use the university portal continuously.	[22]

their attitude towards using the same technology will be more positive leading to an increased possibility of acceptance by users in general.

The assessment of PEOU is influenced by a number of factors such as the intuitiveness of the user interface, clarity of system instructions, simplicity of system navigation and overall user experience.

Davis's research underscores that perceived ease of use is not only crucial on its own but is intricately linked to another key TAM concept: Perceived Usefulness (PU). Users often weigh both PEOU and PU when deciding whether to adopt a new technology. A technology perceived as both easy to use and useful is more likely to garner user acceptance and successful implementation.

In practical terms, organizations and designers can enhance the PEOU of their Information and communications technology (ICT) systems by investing in user-friendly interfaces, providing clear instructions, and minimizing complexities in system operations. Understanding and addressing users' PEOU are essential steps toward fostering a positive user experience and promoting the successful integration of Information and communications technology (ICT) across various domains.

An overview of the questions which can act as predictor for the factors PEOU can be found in Table VII.

TABLE VII
SURVEY QUESTION FOR DETERMINING PERCEIVED EASE OF USE (PEOU)

No.	Perceived Ease of Use (PEOU)	Reference / Defined in
1.	It is easy to learn how to use Moodle.	[24]
2.	It is easy to become a skilful at using Moodle.	[24]
3.	It is easy to operate Moodle.	[24]
4.	Moodle is flexible to interact with.	[24]
5.	Overall, Moodle is easy to use.	[24]

II-D2 Perceived Usefulness (PU)

Notably, The Technology Acceptance Model (TAM) by Davis [23] demonstrates a key role of Perceived Usefulness (PU) in the acceptation and adoption models that are based on the evaluation of technology. In other words, this parameter shows how an individual considers certain software or device as something able to improve his or her performance and productivity.

Among significant factors for adopting a new technology in TAM, there is PU. When users feel that technology can help them to deal with their tasks or hobbies effectively, and efficiently they are likely to embrace it. One cannot detach this idea from the user's perception of possible enhancements in effectiveness, efficiency and overall performance when dealing with a given ICT system or technology.

Functionality, features, and capabilities are typical attributes that affect PU. In fact, users consider if the technology meets their needs, goals, and requirements for PU. For example, software that automates complicated tasks; helps in productivity improvement or provides valuable insights will be considered useful by its users.

The implication of PU extends far beyond the early stage of acceptance, and it directly influences user behaviour as well as continued use of the technology. If users continue to see a technology as useful, they are more likely to keep using it in the future. This

TABLE VIII
SURVEY QUESTION FOR DETERMINING PERCEIVED USEFULNESS (PU)

No.	Perceived Usefulness (PU)	Reference / Defined in
1.	Moodle would enable me to achieve tasks more quickly.	[24]
2.	Using Moodle would improve my learning performance.	[24]
3.	Using Moodle would help me learn effectively.	[24]
4.	Using Moodle would make it easier to achieve learning tasks.	[24]
5.	Overall, Moodle is useful.	[24]
6.	Using Moodle would increase my productivity in my course work.	[25]
7.	Using Moodle gives me greater control over learning.	[25]
8.	By using the functions of Moodle I can concentrate more on my other studies.	[25]

prolonged PU ultimately leads to the long-run success and integration of the technology into daily habits.

Furthermore, PU is closely linked with another significant TAM constituent which is PEOU. Both factors are often considered by users during their evaluation process since a system that not only easy to use but also substantially boosts their performance is more likely to be accepted and assimilated.

For example, organizations can increase PU by making sure that it addresses user needs, has direct benefits for them, and aligns with their objectives. This may entail continuous improvements, updates, or mechanisms allowing user feedback which would enable adapting technology so that it meets changing customer requirements.

During the background research for PU survey questions for determining PU could be figured out as shown in Table VIII.

II-D3 Information quality (IQ)

Information Quality (IQ) and its effects on student satisfaction within academic settings are complex issues. These include data quality, information delivery and the relevance of content to educational needs among others. The importance of understanding this relationship lies in the fact that it has an influence on students' learning experiences, academic performance as well as on their overall satisfaction.

The accuracy, relevance and timeliness of information are at the heart of IQ. This means that educational materials must be of high quality in an academic environment, sources must be credible, and the information must be relevant to specific learning outcomes. According to a research done by Knight and Burn [26], this paper focused on how important and accessible college students require higher learning information hence whether such details would satisfy them based on whether it meets their academic needs or not.

Additionally, the mode of information delivery has a crucial part to play. The digital age has introduced different online platforms and digital libraries, increasing the availability of information. Nevertheless, easy access must be counterbalanced by the credibility and trustworthiness of the same. Grimes and Boening [27] studied the problems students experience when trying to find their way through enormous volumes of digital materials, which further stressed on creating efficient literacy programs for Student Satisfaction (SS).

Besides, one also needs to consider interactivity and user experience. For instance, student satisfaction can be improved by interactive learning environments which include multimedia resources, engaging content and collaborative tools. According to Piccoli et al. [28], online courses that are interactive and well-designed can lead students to heightened satisfaction as opposed to conventional lecture method.

Also, information personalization is a key concern. Personalized content for individual learning styles and preferences has been found to significantly improve SS. The report by

TABLE IX
SURVEY QUESTION FOR DETERMINING INFORMATION QUALITY (IQ)

No.	Information Quality (IQ)	Reference / Defined in
1.	Available information on the university portal are rich.	[22]
2.	My university portal provides information related to my needs.	[22]
3.	My university portal provides up-to-date information.	[22]
4.	My university portal provides accurate information.	[22]
5.	Information displayed on the portal are useful to students.	[22]
6.	The chosen e-Learning tool provides important and helpful knowledge and information for my study.	[25]
7.	Overall knowledge or information provided by the chosen e-Learning tool is satisfactory.	[25]
8.	This e-learning tool makes it easy for me to share ideas with my group mates.	[25]
9.	The knowledge or information provided from the e-learning system (Moodle) is available at a time suitable for its use.	[25]
10.	The information provided by the e-learning system appears readable, clear and well formatted.	[25]

Hwang and Chang [29] showed that personalized learning settings that adapt themselves to each single individual's path of learning along with their preferences could make the difference in terms of how satisfied a student is.

Quality assurance mechanisms in educational institutions also impact SS with IQ. Regular assessments of educational resources, feedback systems, and continuous improvement processes ensure that information remains relevant, accurate, and up-to-date.

Lastly, the role of faculty in mediating and delivering information is crucial. Instructors' expertise, their approach to integrating various information sources, and their ability to guide students through complex information landscapes significantly affect student satisfaction.

While exploring the survey questions used in inquiries to assess IQ, they are compiled into a table IX.

II-D4 System quality (SyQ)

In their work Balaban et al. [30] provided a definition of System Quality (SyQ) as "*Measures of the information processing system itself*", emphasizing the assessment of the technical success of the system. This definition primarily focuses on technical specifications rather than the user experience, particularly in the context of Moodle, which includes aspects such as usability, functionality, user interface, and security. A central aspect explored in this feasibility thesis is whether it is viable to incorporate dimensions like response time, system reliability, and processing capabilities in a manner that enables the administration of a Higher Education Organization (HEO) to gauge student satisfaction throughout an ongoing course. This approach would directly target using Internet of Things (IoT) devices be applied on the Internet of Behaviour (IoB) concept to extract knowledge of the so gathered data.

As shown in Table X, the question collection from other outer sources related to IQ.

II-D5 Service Quality (SvQ)

Service Quality (SvQ) generally refers to the level of assistance a service provider offers. As Delone and McLean [31], has shown in their work, SvQ is within the e-commerce environment is getting more and more important. Users should be treated as customers, rather than employees or in terms of Moodle as student, and poor user support will convert into lost customers. Within the scope of Moodle, this type of support varies among Higher Education Organization (HEO)s, encompassing technical, administrative, and content-related areas. Each of these support domains is usually managed by specific departments within an organization.

Technical support, focusing on the technological aspects of the Moodle system, is typically handled by the Information and communications technology (ICT) department.

TABLE X
SURVEY QUESTION FOR DETERMINING SYSTEM QUALITY (SYQ)

No.	System Quality (SyQ)	Reference / Defined in
1.	The e-learning system can give the means for taking tests and turning in assignments.	[25]
2.	The e-learning system enables interactive communication between the instructor and learners.	[25]
3.	The response time of the e-learning system is consistent.	[25]
4.	The response time of the e-learning system is reasonable.	[25]
5.	The layout of the e-learning system is user-friendly.	[25]
6.	The layout of the e-learning system is in good structure.	[25]
7.	Portal looks attractive in terms of colours and font.	[22]
8.	Information was classified into specific categories in a simple way.	[22]
9.	All the available services are working without problems.	[22]
10.	The personal information I provided is secured.	[22]
11.	Web pages loaded quickly.	[22]
12.	Portal is available all the time.	[22]

On the other hand, tasks such as student enrolment in courses and the maintenance of accurate student records are often the responsibility of the student administration department. Content creation and management within the courses are primarily the duty of the teachers, and services regarding content are done via the channel the student and teachers are aligning too. It is not uncommon that questions regarding the learning content is done outside the Moodle system, for example via Mail, Social Media and similar. Moodle itself offers possibilities to provide that service but is depended on the organization implementation of the service itself.

Additionally, some organizations, depending on their size and operational structure, might set up a general Help-Desk. This serves as a central point of contact for students seeking any of the aforementioned services. Such a Help-Desk is responsible for addressing routine inquiries and directing more specialized or uncommon issues to the relevant department.

TABLE XI
SURVEY QUESTION FOR DETERMINING SERVICE QUALITY (SVQ)

No.	Service Quality (SvQ)	Reference / Defined in
1.	A specific person (or group) is available for assistance with system difficulties.	[25]
2.	ICT staff respond promptly.	[25]
3.	Overall, support services of the e-learning system are satisfactory.	[25]

During literature research it could be figured out that measuring this specific Quality measurement is not considering all services in the practical usage of Moodle at a HEO. Lwoga [25] survey took mainly the technical processing in terms of service into consideration. Shaltoni et al. [22] was focusing on Service Availability with the understanding of the existing of specific external and internal functions. Specifically, the survey asked the participants if a registration service, electronic, linking to social services or providing an email service is done in general by the HEO.

In conclusion, the measuring of SvQ is highly depended on how the HEO has implemented Moodle in the organization. Furthermore, SvQ can also be considered as a field of using Internet of Things (IoT) Data to determine the Internet of Behaviour (IoB) concept.

The gathered survey questions while conducting this thesis can be bound in Table XI.

II-D6 Computer Self-Efficacy (CSE)

Computer Self Efficacy (CSE) is a major determinant of how people engage with technology, particularly in the environment of academic institutions. This concept falls under Bandura [32] extensive self-efficacy theory and refers to an individual's confidence in using computers effectively. It has been widely researched in many research works on

the adoption of technology in education.

The COVID-19 pandemic study by Zhao and Zhao [33] on University Faculties in China provided important findings about CSE's role in technology adoption for online teaching. Unlike other forms of education, the sudden shift to online education due to the pandemic was met with various challenges, especially among faculty members who were previously hesitant regarding technology integration. The results of this analysis indicated that CSE had a significant effect on their Perceived Ease of Use (PEOU) of online teaching technologies. Online teachers having higher levels of CSE were not nervous or frustrated when facing online teaching tasks; instead, they found it easier to handle technological problems and regarded online teaching as a possible task to accomplish.

In this study, digital nativity was also explored. Digital nativity refers to the innate comfort with technology seen in those who have grown up with it. It was found that digital nativity significantly correlated with Perceived Usefulness (PU), attitudes towards technology, and CSE, thus impacting the adoption of technology for online teaching. Interestingly, even faculty members born before the era of digital natives demonstrated features of digital nativity when they became familiar with information and communication technologies through constant use.

The study results further illustrate that PU and PEOU of technology are intertwined with attitudes towards online teaching. This affects the willingness of teachers to use these technologies. Teaching staff who perceive technology as beneficial and easy to use, tend to have positive attitude toward its inclusion in their teaching methodologies. Remarkably, the connection between CSE and PEOU is striking. It suggests that trust in one's technological competence may make the idea of online teaching appear less formidable and more accessible.

In their study on the impact of CSE with respect to the use of the Blackboard Learning Management System [34], Binaymin et al. [24] conducted research based on a survey typically administered at the end of the course. This survey relied on self-assessment by the participants. The idea of question which were asked regarding the Blackboard

TABLE XII
SURVEY QUESTION FOR DETERMINING COMPUTER SELF EFFICACY (CSE)

No.	Computer Self Efficacy (CSE)	Reference / Defined in
1.	I usually achieve the tasks in Moodle without help.	[24]
2.	I have the skills needed to use Moodle.	[24]
3.	I learned how to use Moodle easily.	[24]
4.	I know about many computer technologies.	[24]
5.	If I face a problem in Moodle, I usually know what I should do.	[24]

Learning Management System can be refactored also for Moodle Learning management system and are listed in Table XII in the appropriate section.

III Conceptional Approach and solution

The conceptual approach for the three hypotheses, taking into account both the research and current knowledge, will be as follows.

III-A Technical perspective

From a technical perspective, the feasibility study will focus on assessing the capability of Moodle's available Survey activities to gather and process satisfaction-related data. Understanding the end-user experience will involve identifying the most relevant measurement points that closely mirror a student's interaction with Moodle. This involves determining whether Moodle's built-in tools can collect the six identified factors or if external tools and processes are needed for autonomous measurement. The plan is to incorporate survey questions based on literature research findings, particularly on Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Information Quality (IQ), and Computer Self Efficacy (CSE). To estimate student satisfaction over a courses' duration, a demo course for a randomly created dataset of at least 20 students, will be set up in Moodle using a set of course related questions. The choice of a randomly created student dataset is done to avoid privacy issues. For the remaining two factors, Service Quality (SvQ) and System Quality (SyQ), strategies will be explored to obtain necessary data externally and integrate it into the Moodle Learning Content Management System (LCMS). The measuring of SyQ should, will be done with a monitoring system which is placed outside Moodle system infrastructure, measuring uptime, responsiveness, validity of SSL certificates which are exposed to the user. But also inside the Moodle infrastructure measuring for SyQ should be undertaken, as an example the connection to an LDAP directory, a Mail Server which can be considered as measure point for Table X (2,

9). As the research showed, SyQ questions also included questions regarding the users personal impression about User Experience (UX), see Table X (5, 6, 7, 8). Since it is state of the art to measure UX experience which Google Analytics, the above-mentioned questions will also be done via the survey activity in Moodle, to not be in conflict with the current legislative since analytics is considered not to be legal under the terms of General Data Protection Regulation (GDPR). The current situation about the situation of Googly Analytics in context of Moodle and GDPR will be investigated in the second part of the proposed solution.

For the feasibility a prototype of this approach will be build to demonstrate the possibility of forecasting student satisfaction within Moodle Learning Content Management System (LCMS), during a course/class.

In case [H1] is in the current version of Moodle not feasible, an approach should be made how it can be done for further version, or what changes need to be done.

III-B Legal perspective

To evaluate the permissibility of examining student satisfaction within Moodle, a meta-analysis will be performed. This analysis will delve into Chapter II and Chapter III of the General Data Protection Regulation (GDPR) specified by European Parliament and Council of the European Union [35], as well as the Fachhochschulgesetz (FHStG) established by Austrian Parliament [36], aiming to ascertain its compliance with Austrian legislation. The theoretical segment of this thesis, notably focusing on Google Firebird Analytics, requires scrutiny, given its widespread use across various industries for tracking user behaviours and experiences on websites. Moreover, this thesis aims to assess potential impacts on the Moodle platform utilized by Higher Education Organization (HEO) and the contractual agreements between these organizations and their students. The examination will feature a specific case study, using Ferdinand Porsche FernFH as an illustrative

example.

III-C Organizational perspective

The study will assess the organizational feasibility of a Higher Education Organization (HEO) effort to implement a system to monitors student satisfaction within Moodle. This study will propose a strategy of collecting data after each subsection of the course since most of the six factors influencing student satisfaction such as Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Information Quality (IQ), Service Quality (SvQ), and Computer Self Efficacy (CSE) can only be measured in Moodle through surveys. Surveys have to be conducted during the course. To ensure there is enough data, a solution will be proposed on what frequency these surveys have to be undertaken. This implementation could also affect the overall course design in HEOs and may impact on Moodle acceptance because students will have to take part in more surveys. Also, it should be evaluated of how many questions should be presented to the students when conducting a survey to gather the required data.

The organization's ability to improve satisfaction with individual courses and overall student satisfaction is another important factor to consider. The feasibility study should identify the specific roles within the HEO that will be involved in collecting and processing this data. Moreover, it should indicate who will be responsible for implementing changes aimed at improving student satisfaction.

IV Appling Approach and solution

IV-A Technical perspective

The setup involves VirtualBox version 7.0.14 build 161095 on Windows, hosting an Ubuntu 22.04 desktop version (64-bit) Virtual Machine This VM is enhanced with VBoxGuestAdditions.iso for better performance and integration, assigned 10,240 MB of RAM, 4 CPU cores, and 75 GB of storage. The project utilizes Moodle 4.3.3+ (MOODLE_403_STABLE), the latest version from the official Moodle repository [37]. Installation adhered to Moodle's official guidelines, starting with Moodle's general installation steps as a foundational guide [38]. Apache/2.4.52 web server configurations were tailored following Moodle's documentation to ensure optimal hosting [39].

As database management system PostgreSQL 14.11 has been selected. The detailed setup procedure for the database for the installation in Moodle is described in the official documentation [40]. For the necessary PHP components Ubuntu version, PHP 8.1.2-1ubuntu2.14, was used [41]. This guaranteed that the server met all requirements for a smooth and efficient Moodle operation.

For the study, thirty anonymized demo student accounts were created in Moodle. The feedback activity was set up to maintain confidentiality, as described by [10], including mandatory questions designed to align with the study's theoretical framework and research methodology. The questions were categorized according to the six student satisfaction factors identified within the framework.

The study design required students to respond to nine questions at three different points in time during one specific course covering the five described key areas (Sect. II): PU, PEOU, CSE, IQ, and SyQ. The SyQ was assessed through external tools, using a mock ticketing system, to gauge responsiveness and availability. The integration with external systems aimed to provide a centralized solution, as elaborated in Sect. III-C. Additionally,

the SyQ evaluation utilized external web service monitoring tools.

To comply with the GDPR regulations, UX inquiries were included in the surveys, as discussed in Sect. III-B. Appendix A describes a Python script that was used to generate simulated student responses for the demonstration. This script biases the responses towards an increasing positive feedback over time, illustrating a hypothetical manipulation of student satisfaction can impact the evaluation outcomes. Essentially, the script creates a series of survey responses for the three distinct surveys carried out during the course, progressively skewing the results towards positivity through a weighted random selection process. Using this simulated data demonstrates the suitability for testing the hypothesizes, offering a controlled environment to observe potential trends or outcomes and paving the way for applying these methods to a real student satisfactory integration.

Subsequently, the responses were entered into Moodle separately for each demo student. Due to a bug in the feedback module's export function, the built-in calculation of averages could not be used. Instead, the use of the export feature to create individual CSV files for each survey used, with applying R to analyse the data B. For each CSV file, the frequency distribution of responses was calculated in each category and stored in separate arrays within R Studio. Finally, another R script (included in C) was used to calculate student satisfaction for all three surveys. This calculation employed equation II.1, which was explained in the theoretical section of the paper.

IV-B Legal perspective

In the second Chapter of the General Data Protection Regulation (GDPR) enacted by the European Parliament and Council of the European Union [35], the foundational principles related to the processing of personal data are defined. Articles 5 through 11 therein, define the duties and responsibilities of data controllers and processors, ensuring that the processing of personal data is conducted in a lawful, fair, and transparent way. Specifically, article

5 states that the gathering of data should be for clear, explicit, and for justified reasons. This chapter regulates, furthermore, that the data collected need to be relevant, sufficient, and not exceed more than needed for the intended processing, upholding the principles of data minimization and accuracy. Furthermore, article 5 specifies that personal data should be kept in a way allowing the identification of individuals only for the duration required to achieve the processing goals. The next article, article 6, lists approved reasons for data processing, such as meeting contractual needs, complying with laws, protecting vital interests, carrying out public functions or fulfilling the data handler's legitimate interests. Article 7 addresses the consent, pointing out that it must be voluntary, specific, well-informed, and clear, with the ability to withdraw the consent it as easily as it was granted. Further, Articles 8 through 11 introduce protections for specific types of sensitive personal data. These categories include details about a person's ethnic or racial origins, their political, religious, or philosophical views, membership in labour unions, identifiers like genetic markers and biometric data, health details, and aspects of someone's private life related to sexual orientation or activity. Typically, the processing of such information is forbidden unless it aligns with certain exceptions in Article 9, such as unequivocal consent or the necessity for important public interest.

The fundamental rights of data subject in relation to processing their personal data are described in Chapter III of the GDPR. It highlights and strengthens the right to information, ensuring data subjects are fully informed about how the collection and use of their personal data. This is including details such as the identity of the data collector, the purpose of processing, and the identity of the recipients. This transparency is vital for fostering trust between data subjects and controllers. Also, the chapter highlights the right of access, allowing individuals to verify whether their data is being processed and to access such data, thereby empowering them to ascertain the legality of the processing activities.

Additional rights advocated in Chapter III include the right to rectification, enabling data subjects to demand that inaccurate or incomplete personal data, thus ensuring data

accuracy and integrity, are removed. It furthermore introduces the ”right to be forgotten”, permitting individuals to request removing their personal data under specific circumstances, e.g. when the data is no longer necessary for its original processing purpose or when consent is withdrawn. Additionally, it outlines the right to restrict processing, which permits data subjects to limit the processing of their data under certain conditions, such as disputing the accuracy of the data or challenging the legality of the processing.

The Fachhochschulgesetz (FHStG) introduced by Austrian Parliament [36], supplemented by additional regulations, ensures the quality of education and services provided by a University of Applies Science (UAS). A key element of this assurance is the measurement of student satisfaction, legally mandated by §3 (9), which states,

> “*The courses must undergo evaluation by the students; the evaluation results serve quality assurance and should be used for the pedagogical and didactic further education of the instructors.*”

”The courses must undergo evaluation by the students; the evaluation results serve quality assurance and should be used for the pedagogical and didactic further education of the instructors.” This requirement establishes the importance of continuous evaluation and adaptation to meet educational demands. The FHStG focuses on ensuring quality through explicit criteria for training, practical relevance, and student evaluations. In this context, the e-learning platform Moodle is an important tool for measuring student satisfaction and supporting quality assurance in UAS.

Moreover, §3 (1) points out the significance of practical relevance and professional orientation in higher education. This is setting Moodle not only as a theoretical learning tool but also as a facilitator of practical applications through simulations, case studies, and interactive projects. Student evaluations conducted through Moodle provide critical insights into the effectiveness of teaching content and methods concerning practical relevance and preparation for professional life. Additionally, this section addresses the necessity for degree programs to be structured such that they can be completed within the designated study period and that the annual workload for students does not exceed

prescribed limits.

These evaluations are important for enhancing educational standards and aligning with the requirements of the FHStG. Moodle offers various tools for collecting and analysing feedback in real-time, enabling an immediate grasp of student experiences. These data assist in optimizing curricula, refining teaching methods, and ultimately improving the student learning experience. Furthermore, §9 (1) highlights the integration of UAS courses into quality assurance and development processes, underlining that the quality of teaching must be ensured by appropriately qualified teaching staff.

While Moodle presents numerous opportunities for supporting quality assurance in HEO, effective utilization of this platform is necessary. The creation of meaningful surveys, ensuring participation, and the accurate interpretation of data are steps to fully realize the benefits of satisfaction measurement. Additionally, HEO must adhere to data protection regulations to guarantee the confidentiality and anonymity of students. Moreover, §3 (2) stresses that degree programs must respect the diversity of scientific opinions and uphold good scientific practice and academic integrity, ensuring a comprehensive and ethically sound educational environment.

IV-C Organizational perspective

The data collection strategy chosen here was gathering data for an entire semester with the timing chosen to allow the demo students being surveyed at three consecutive points during a semester, determining a trend development. Using two questions per factor affecting student satisfaction, coupled with a high response rate to the survey responses, it was ensured that an estimation of these trends could be made. For this reason, the surveys were configured as mandatory for the entire semester cohort, so that the reliability of the evaluations could be increased. The frequency of the surveys was set to a monthly cycle, with a total of 9 questions per survey chosen so that the survey participants are not overwhelmed, and their satisfaction is not affected by a higher survey frequency. Investigations were carried out to determine whether the measurement of student satisfaction during the semester could also be conducted at the course level. While this is technically possible, as the feedback module can also be used within the course itself, this was avoided as it would lead to a very large number of surveys. Potential approaches solving this issue will be discussed in later chapters.

For the surveys themselves, the university/faculty management has to ensure that the goals of the institution are aligned with the surveys. Furthermore, the management should coordinate the various involved stakeholders and ensure that the project is successfully completed. The academic staff and the administrative members of the faculty play a key role in measuring student satisfaction. If participation in the surveys is not mandatory, it is extremely important to motivate students to participate in the studies; otherwise, the sample may appear too small to identify a trend in student satisfaction. Additionally, administrative members must ensure that the surveys are implemented in the individual classrooms/courses and are available to the respective student groups. If the administrative members do not take care of the further data processing of the surveys, the role of a data analyst, who processes and analyses the data, must also be considered and clearly

defined. They are obligated to draw meaningful conclusions from the data obtained.

It is important to have members within the technical team who are responsible for overseeing the technical aspects of the implementation process. One of the primary goals should be the integration of essential interfaces with Moodle. Moreover, the responsibility of ensuring data security and adherence to the GDPR should also fall within the purview of the Technical Team's responsibilities.

One role that should be also involved in this process is the student representative, who should mediate between the students and the members of the HEO. This representative should ensure, in the context of measuring student satisfaction, that the concerns of the students, especially regarding any potential improvements identified through the satisfaction measurement, are preserved.

To ensure the success of this initiative, a comprehensive communication plan is crucial. This plan is facilitating a transparent and continuous information flow among all stakeholders involved in the student satisfaction monitoring process. Before launching the survey initiative, an initial briefing should be conducted for all stakeholders. This briefing needs to outline the objectives, methodology, expected outcomes, and the importance of their participation in enhancing the educational experience. During the semester, regular updates need to be provided to keep all stakeholders informed about the survey progress, participation rates, and any preliminary insights or adjustments made to the survey methodology based on initial feedback. After each survey phase, detailed reports should be prepared and presented to both the university management and the faculty, highlighting key findings, trends, and areas for improvement. A summarized version of these findings has to be communicated to students, emphasizing how their feedback contributes to shaping their educational experience. When actions are taken based on the survey results, detailed communication is made regarding what changes are being implemented, the rationale behind these changes, and how they aim to enhance student satisfaction. This step ensures that all participants in the survey process see the tangible outcomes of their participation. At the end of the semester, a comprehensive review has to

be shared with all stakeholders, summarizing the actions taken, the improvements made, and the plans for the next steps in the continuous effort to enhance student satisfaction. Establish an ongoing dialogue mechanism, such as forums or feedback sessions, where students and staff can continuously share their thoughts and suggestions outside the formal survey structure. This will help maintain a responsive and adaptive learning environment, reinforcing the community's commitment to continuous improvement.

V Results

V-A Technical perspective

The table XIII presents the results of the three undertaken surveys, focusing on factors that contribute to the student satisfaction. Their interplay and collective impact on student satisfaction, which is calculated from these, offer insights into the student satisfaction. In the surveys, each factor is quantified, providing a numerical expression of its perceived presence in the educational context, see figure 4. Analysing the progression from Survey 1 to Survey 3, there is a visible trend in the evolution of student satisfaction. Initially, in Survey 1, student satisfaction is at a certain level, see figure 5. offering a baseline students satisfaction at beginning of the course. As we move to Survey 2 and Survey 3, there is a noticeable increase in student satisfaction value. This upward trajectory could imply that over time, either the students perceptions have shifted, or there have been tangible improvements in the factors contributing to their satisfaction. This increase in student satisfaction might not be uniform across all factors, as each factor could have varying degrees of influence on the overall satisfaction score. The table and figures also highlights how different factors have evolved over the course of the three surveys. This differential improvement can offer educators and administrators insights into which areas have the most substantial impact on student satisfaction and where resources or efforts could be best allocated to enhance the educational experience.

TABLE XIII
SURVEY RESULTS

Factors	Survey 1	Survey 2	Survey 3
PEOU	3.616667	3.450000	3.366667
PU	3.366667	3.466667	3.416667
IQ	3.650000	3.400000	3.233333
SyQ	3.311111	3.922222	4.388889
SvQ	3.000000	4.000000	5.000000
CSE	3.766667	3.766667	3.650000
Student satisfaction	3.483956	3.732244	3.917761

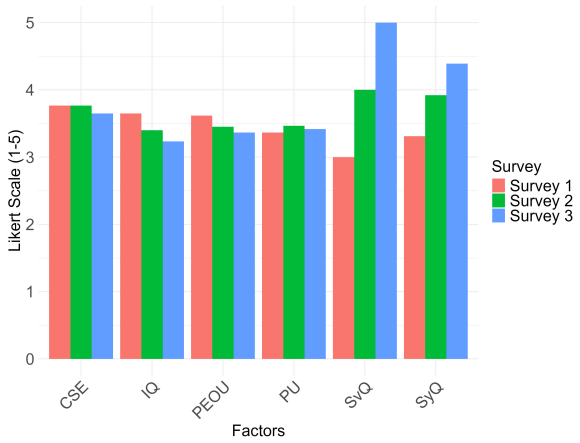

Fig. 4. Bar chart for comparing each factor for each conducted survey

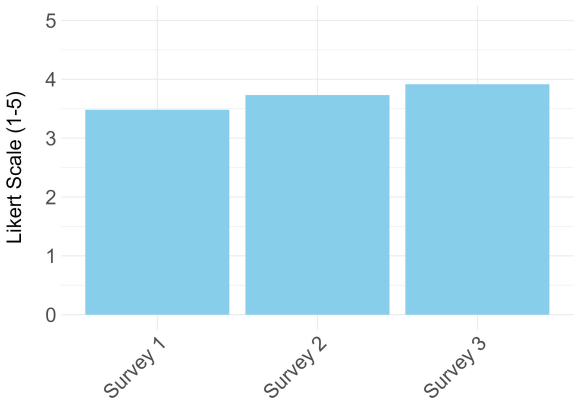

Fig. 5. Student Satisfaction Evolution through the course

V-B Legal perspective

Any processing of data, including the one which are relevant to measure student satisfaction data Moodle, must be in lawful, fair and transparent way. Students should be made aware of the types of data being gathered, the reason why it is collected, the intended use of the data and any third parties that is involved in handling the data. To maintain transparency is essential so that students understand how their data is being used This can be achieved through clear privacy notices and consent mechanism, like signing an educational contract between the HEO and student. The personal data must be gathered for defined, specific and lawful reason, and should not be processed in a way that do not align with this purpose. When evaluating student satisfaction within Moodle, it is important to ensure that the data which is collected is only used for improving the educational experience and supporting students learn outcomes. In the case of forecasting student satisfaction in Moodle, it is essential to concentrate purely on the information that directly contributes for measuring students satisfaction. Collecting additional data beyond what is necessary can raise privacy concerns and goes against the principle of data minimization. Additionally, the accuracy of the data is vital, as it must accurately represent the true experiences and opinions of the students. The personal data should only be stored in a way that allows for the identification of individuals as long as needed to fulfil the intended purposes. Additionally, the data should only be retained as long as necessary to achieve the measurement Once the data is no longer needed they should be securely deleted or anonymized to protect students privacy. It is essential to guarantee suitable security measures are in place to protect against unauthorized or illegal processing, as well as to prevent accidental loss, destruction or damage of the data. By adhering to the principal outlined in Chapter II General Data Protection Regulation (GDPR) European Parliament and Council of the European Union [35], the examination of student satisfaction within Moodle can be conducted in a manner that respects students privacy

rights and complies with the regulatory requirements regarding the processing of personal data. Higher Education Organization (HEO), as data controllers, must adhere to GDPR principles and show that they are in compliance, with them. This involves maintaining detailed logs of processing actions, undertake data protection impact assessments when needed, and working in collaboration with overseeing bodies. It is also necessary to perform a comprehensive evaluation of the particular data collection and processing methods to guarantee adherence to all pertinent principles and stipulations of the GDPR.

§3 (9) [36] articulates the legal foundation for student satisfaction measurements. According to this, all courses offered at a UAS must undergo evaluation by students themselves. This directive is not a procedural formality but an important component of the academic quality assurance framework. The feedback gathered through these evaluations is important for refining strategies and enhancing the performance of a UAS.

As described in the FAQ of the Feedback Activity [42]

> No. For the 'Record user names' setting even in Anonymous mode the username of the user who took the Feedback is still recorded in the database just as with non-anonymous Feedbacks, but the name is not showed to anyone on screen in Moodle or in reports or downloads. Anyone who has direct access to the database could see and extract the name of the user who took an anonymous feedback. This explains why Activity completion still works in Anonymous mode since it actually knows the user who completed the Feedback.

However, the presented implementation of the measurement used the reporting feature and was conducted with a user who does not have administrator rights for any technical component. Since the report itself only shows averages and an absolute frequency of responses given to a survey, this method is compliant with GDPR.

V-C Organizational perspective

The conceptual approach for the implementation of a student satisfaction monitoring system within Moodle at a HEO outlined a methodical and empirical understanding of student satisfaction over an academic semester. The methodology, predicated on administering surveys at three crucial points, is designed to capture the evolution of student satisfaction, providing a lens through which fluctuations and influencing factors can be examined. The design of the feedback module in Moodle, limiting the questionnaire to nine items with a focus on each determinant of satisfaction, implements an equilibrium between the depth of examination and the pragmatic considerations of respondent engagement. This equilibrium is pivotal, as it ensures the induction of substantive data while mitigating the risk of respondent fatigue, a factor known to potentially compromise data validity and response rates. The mandate for student participation in the survey represents a strategic initiative to response representativeness, enhancing the robustness of the resultant data. However, this mandate necessitates a transparent and communicative approach to point out the significance and utility of the students' contributions, fostering a sense of investment and perceived value in the feedback process. The pictured responsibilities of university management, academic staff, administrative personnel, data analysts, and technical teams constructs a collaborative infrastructure essential for the effective operationalization and execution of the monitoring system. Such role clarity is instrumental in fostering a synergistic effort towards the enhancement of student satisfaction.

To fully comply with data protection standards, especially those outlined in the GDPR, it's important to have a Data Protection Officer on board. The DPO main tasks are to manage the data protection strategy and oversee its execution to meet GDPR mandates. Key duties of the DPO include the following: tracking of compliance within the organization, advising in terms of data protection laws, and educating the organization about its

obligations. A DPO ensures the legal and ethical treatment of personal data, processed in a transparent, secure, and respectful way ensuring privacy, which is essential for the effectiveness of any monitoring system.

The inclusion of a technical team, particularly tasked with ensuring compliance with the GGDPR and safeguarding data integrity, underscores the commitment to ethical standards and data security. This facet of the approach not only adapt to legal mandates but also serves to sustain the trust and engagement of the student cohort, factors that are critically linked to the success of such monitoring undertaking.

An elaborate communication strategy underlines this approach, facilitating a transparent and iterative exchange of information among all stakeholders involved. This strategy is designed to not only maintain engagement but also to demonstrate the iterative nature of the process, wherein feedback is continuously harvested, analysed, and translated into actionable insights and enhancements.

VI Conclusion

VI-A Answering Hypothesis

Hypothesis 1 *The technical implementation of such a monitoring system is feasible, as data that is already available within Moodle and needs to be evaluated in the context of human psychology.*

To answer this hypothesis, yes, it is technical possible to create a system for monitoring the degree of satisfaction of students with a course. The implemented and created system used the information already available on Moodle and considered factors like psychology of individuals. To verify this, simulated student responses to surveys were created at different times during a course to see how student satisfaction might change. This data was analysed using specified and published equations to calculate student satisfaction levels. The result shows that Moodles inbuilt features can be used effectively to measure and understand levels of students satisfaction over time. By using Moodle's feedback activities and analysing the data, it's possible to see throughout the respective course how satisfied students are with their course work and provided materials. Concluding, hypothesis 1 is proved implying that Moodle already has the tools and data necessary for integrating a system that will enable educators to track the level of learner contentment. Such a system can reveal valuable insights about students experiences thereby helping teachers and administrators improve teaching and learning according these findings.

Hypothesis 2 *From a legal perspective, there will be an impact on the quality of predictions, as anonymization and pseudonymity will impose restrictions on data processing.*

The method applied in this thesis for measuring student satisfaction is based on a reporting feature that restricts user rights due to its conduction by an unprivileged user as administrative rights are required to access the technical parts. This ensures that there are no unauthorized alterations or any breach of conduct. Additionally, the report created

only provides overall statistical information such as averages and how frequently people responded without revealing personal identification information, conforming to GDPR principles on personal data protection and privacy breach prevention. Furthermore, it does not process personal data and delivers only information it was designed for. Therefore, this hypothesis can be rejected.

Hypothesis 3 *The operational implementation may not be possible for every organization, as data needs to be evaluated and contrasted with human behaviour. Not all HEOs will have the resources to provide such a service.*

The operational implementation is resource-intensive and demands extensive data collection as well as precise analysis. It is a mixture of a technical demanding infrastructure, experts, and a lot of time resources equalling to heavy financial investments. This highlights the degree of knowledge and technologically intensive methods necessary for data analysts and technical personnel who control, analyse, and protect the data.

These resources can be used to examine student feedback and behaviour, too, but might not be equally accessible to all HEO especially for smaller dimensioned, resource wise, ones. The method requires, furthermore, knowledge in human behaviour as well as educational psychology to correctly interpret the data within students experiences. This analytical approach is beyond gathering data; it requires an advanced method of extracting meaningful information from student feedback.

Such analytic expertise would enable raw information to be transformed into meaningful improvements in education quality and satisfaction levels among students. Furthermore, the strategy involves detailed communication plan with stakeholders engagement crucial in accepting system usefulness. This calls for staff solely dedicated to communication matters as well as encouraging stakeholder support hence increasing further the resource needs. Essentially, the system must be able to encourage continuous improvement using data analysis. To do this there is a need for an adaptive organization that can change based on insights from data.

Lastly, the system's need for scalability and adaptability suggests it must be customiz-

able to meet the diverse needs and contexts of various HEO. This adaptability could be a challenge for institutions that have poor digital infrastructure or those unable to modify their systems in line with their peculiar circumstances.

Considering these factors, it is evident that while the suggested approach provides an exhaustive framework for boosting student satisfaction via data-driven insights, its practicality hinges on the presence of considerable resources and capabilities. Therefore, it is plausible that not all HEO will be capable of adopting such a system due to these limitations, underscoring the necessity of evaluating an institution's preparedness and resource availability before embarking on such an initiative.

VI-B Answering Research question

Evaluating the feasibility of determining student satisfaction using data from the Moodle learning management system is promising from technical, legal, and operational perspectives. Technically, Moodle's built-in tools are capable of gathering and analysing data related to student satisfaction. The study highlights the platform's functionalities, which support the collection of key satisfaction indicators such as perceived ease of use, perceived usefulness, information quality, system quality, service quality, and computer self-efficacy through surveys conducted at different intervals during a course. Additionally, developing new Moodle activities and direct integration with external tools can further enhance data collection and analysis capabilities.

Legally, the study addresses data privacy concerns by ensuring compliance with the General Data Protection Regulation (GDPR). Anonymization and pseudo-anonymization techniques are employed to protect personal data while still enabling meaningful analysis. The research indicates that these legal constraints do not significantly impact the system's effectiveness, as it is possible to process and deliver statistical outcomes without compromising personal privacy.

Operationally, implementing such a system requires substantial resources, which may pose challenges for smaller or less resourced higher education organizations (HEOs). The study emphasizes the need for a collaborative approach involving various stakeholders, including technical teams, data analysts, and academic staff, to ensure successful data collection, analysis, and application. Ensuring sufficient financial and technological resources is crucial for effective implementation and utilization of the system.

Overall, while technically and legally feasible, the successful deployment of a Moodle-based student satisfaction monitoring system depends significantly on the operational capacity and resource availability of the implementing institution.

VII Summary

VII-A Summary

This study confirms that using Moodle to create a monitoring system for measuring students satisfaction is feasible. Using existing Moodle functionalities, data measuring student satisfaction with respect to the courses/classes they participated in was efficiently gathered and analysed. The method applied not only supports the technical implementation of such a system, but also showed that Moodle possesses the required tools for enabling HEO to track and enhance learner efficiency. From the legal perspective, the study addresses potential concerns regarding data privacy and the impact of anonymization on the quality of predictions. The finding suggests that despite these constraints, the system can still process and deliver statistical outcomes without compromising personal privacy. Thus, legal constraints do not significantly hinder the gathered data, thereby rejecting concerns that legalities could adversely affect the system effectivity. However, the feasibility of implementing across HEO poses a challenge, particularly due to the resource-intensive nature of such a task. Not all HEO posses the necessary financial and technological resources required to analyse and interpret the data effectively. This highlights an important limitation as smaller or less resourced institutions might struggle to adopt the system.

VII-B Outlook

Since 36% of II.1 is still undetermined, future research should address more advanced behavioural analytics methods to reduce the uncertainty factors which are influencing students satisfaction. For a better understanding which factors are influencing student

satisfaction, it could be beneficial to add additional data sources beyond the Moodle platform. This could for example include data from other educational tools, social media interactions or even biometric data (of course with proper ethical and privacy considerations). Also, future studies could focus on the psychological factors which are influencing students satisfaction to understand behaviours which are not explained by the current data. On the long run, longitudinal studies are required to track changes in student behaviour over time which could reveal new patterns to clarify the undetermined factors. For example, these studies could focus on the individuals students progression through a course/class to identify triggers and outcome of specific moments which are influencing the satisfaction. Another good approach to get a deeper understanding in students satisfaction in Moodle could be a collaborative research effort. Since this topic touches several areas, this collaborative effort could be undertaken by experts in education, psychology, data science and computer science to establish new methodologies for a better capturing and interpretation of student behaviour, reducing the percentage of undetermined factors.

From the technical point of view, a newly programmed activity could also help integration in Moodle. This could focus on a more direct implementation inside Moodle, skipping data processing with an analysing tool. Also, the data acquired by Moodle could then be purely fetched within the Moodle Ecosystem, namely directly from the provided database. Furthermore, for getting a better spread of questions that are being asked, this new module could address shuffling the questions for every student, keeping the same amount of questions per factor. This would help to have a more granular insight into the six factors and HEO could get more specific feedback. Additionally, this module could be extended to do not ask a certain amount of question at one time, rather than raising the frequency with fewer questions focusing on only one factor per time. This could help organizations to act more agile on the so gathered student satisfaction. Lastly, a more direct integration of external tools via Web service in Moodle could be examined, to store also this data in the Moodle-Ecosystem.

References

[1] M.-J. Wu, K. Zhao, and F. Fils-Aime, "Response rates of online surveys in published research: A meta-analysis," *Computers in Human Behavior Reports*, vol. 7, p. 100206, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2451958822000409

[2] G. Nyman, "The psychology behind internet of behaviors (iob)," Online: https://gotepoem.wordpress.com/2012/10/04/the-psychology-behind-internet-of-behaviors-ib/, 2012, accessed: 2023-04-01.

[3] F. Xia, L. T. Yang, L. Wang, and A. Vinel, "Internet of things," *International Journal of Communication Systems*, vol. 25, no. 9, pp. 1101–1102, 2012. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/dac.2417

[4] O. H. Embarak, "Internet of behaviour (iob)-based ai models for personalized smart education systems," *Procedia Computer Science*, vol. 203, pp. 103–110, 2022, 17th International Conference on Future Networks and Communications / 19th International Conference on Mobile Systems and Pervasive Computing / 12th International Conference on Sustainable Energy Information Technology (FNC/MobiSPC/SEIT 2022), August 9-11, 2022, Niagara Falls, Ontario, Canada. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1877050922006202

[5] Moodle, "Moodle - official homepage," Online: https://moodle.org/, 2023, accessed: 2023-05-11.

[6] A. Al-Ajlan and H. Zedan, "Why moodle," *Future Trends of Distributed Computing Systems, IEEE International Workshop*, vol. 0, pp. 58–64, 10 2008.

[7] Moodle, "About moodle," Online: https://docs.moodle.org/403/en/About_Moodle, 2023, accessed: 2023-05-11.

[8] J. Cole and H. Foster, *Using Moodle: Teaching with the Popular Open Source*

Course Management System. O'Reilly Media, Inc., 2007.

[9] M. Dougiamas and P. C. Taylor, "Interpretive analysis of an internet-based course constructed using a new courseware tool called moodle," 2023, accessed: 2023-06-11. [Online]. Available: https://dougiamas.com/archives/herdsa2002/

[10] Moodle, "Moodle feedback activity," Online: https://docs.moodle.org/403/en/Feedback_activity, 2023, accessed: 2023-05-12.

[11] ——, "Moodle questionnaire module," Online: https://docs.moodle.org/403/en/Questionnaire_module, 2023, accessed: 2023-05-12.

[12] ——, "Moodle app," Online: https://moodle.com/solutions/moodle-app/, 2023, accessed: 2023-13-11.

[13] H. J. Han, ""how dare they peep into my private life?"," Mar 2023, accessed: 2023-13-11. [Online]. Available: https://www.hrw.org/report/2022/05/25/how-dare-they-peep-my-private-life/childrens-rights-violations-governments

[14] Moodle, "Moodle's data protection pledge of commitment," Oct 2023, accessed: 2023-13-11. [Online]. Available: https://moodle.com/news/moodles-data-protection-pledge-commitment/

[15] J. Sun, W. Gan, H.-C. Chao, P. S. Yu, and W. Ding, "Internet of behaviors: A survey," *IEEE Internet of Things Journal*, vol. 10, no. 13, pp. 11 117–11 134, 2023.

[16] M. Javaid, A. Haleem, R. P. Singh, S. Rab, and R. Suman, "Internet of behaviours (iob) and its role in customer services," *Sensors International*, vol. 2, p. 100122, 2021. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2666351121000437

[17] N.-T. Nguyen, "A study on satisfaction of users towards learning management system at international university – vietnam national university hcmc," *Asia Pacific Management Review*, vol. 26, no. 4, pp. 186–196, 2021. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1029313221000336

[18] H. Toring, G. Legaspi, J. Omolon, R. Amadeo, E. Amadeo, Q. Opolentisima,

V. Barina, T. Cacho, F. Illustrimo, and S. Cortes, “Evaluation of students’ satisfaction toward an adopted learning management system at indiana aerospace university: A structural equation modelling approach,” *Asia Pacific Management Review*, vol. 28, no. 3, pp. 336–346, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1029313222000720

[19] M. Alkhateeb and R. Abdalla, “Factors influencing student satisfaction towards using learning management system moodle,” *International Journal of Information and Communication Technology Education*, vol. 17, pp. 138–153, 01 2021.

[20] R. Likert, *A technique for the measurement of attitudes / by Rensis Likert.*, ser. Archives of psychology ; no. 140. New York: [s.n.], 1985 - 1932.

[21] L. Cronbach, “Coefficient alpha and the internal structure of tests,” *Psychometrika*, vol. 16, no. 3, pp. 297–334, September 1951. [Online]. Available: https://ideas.repec.org/a/spr/psycho/v16y1951i3p297-334.html

[22] A. Shaltoni, H. Khraim, A. Abuhamad, and M. Amer, “Exploring students’ satisfaction with universities’ portals in developing countries,” *International Journal of Information and Learning Technology*, vol. 32, pp. 82–93, 03 2015.

[23] F. D. Davis, “Perceived usefulness, perceived ease of use, and user acceptance of information technology,” *MIS Q.*, vol. 13, pp. 319–340, 1989. [Online]. Available: https://api.semanticscholar.org/CorpusID:12476939

[24] S. Binaymin, M. Rutter, and S. Smith, “The influence of computer self-efficacy and subjective norms on the students’ use of learning management systems at king abdulaziz university,” *International Journal of Information and Education Technology*, vol. 8, pp. 693–699, 10 2018.

[25] E. T. Lwoga, “Critical success factors for adoption of web-based learning management systems in tanzania,” *International journal of education and development using information and communication technology*, vol. 10, pp. 4–21, 2014. [Online]. Available: https://api.semanticscholar.org/CorpusID:46217949

[26] S.-a. Knight and J. Burn, “Developing a framework for assessing information quality

on the world wide web," *Informing Science Journal*, vol. 8, pp. 159–172, 09 2005.

[27] D. J. Grimes and C. H. Boening, "Worries with the web: A look at student use of web resources," *College & Research Libraries*, vol. 62, pp. 11–23, 2001. [Online]. Available: https://api.semanticscholar.org/CorpusID:61208155

[28] G. Piccoli, R. Ahmad, and B. Ives, "Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic it skills training," *MIS Quarterly*, vol. 25, pp. 401–426, 12 2001.

[29] G. Hwang and H. Chang, "A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students," *Comput. Educ.*, vol. 56, pp. 1023–1031, 2011. [Online]. Available: https://api.semanticscholar.org/CorpusID:44306783

[30] I. Balaban, E. Mu, and B. Divjak, "Development of an electronic portfolio system success model: An information systems approach," *Computers & Education*, vol. 60, no. 1, pp. 396–411, 2013. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S036013151200173X

[31] W. Delone and E. McLean, "Measuring e-commerce success: Applying the delone & mclean information systems success model," *International Journal of Electronic Commerce*, vol. 9, pp. 31–47, 09 2004.

[32] A. Bandura, "Self-efficacy: Toward a unifying theory of behavioral change," *Advances in Behaviour Research and Therapy*, vol. 1, no. 4, pp. 139–161, 1978, perceived Self-Efficacy: Analyses of Bandura's Theory of Behavioural Change. [Online]. Available: https://www.sciencedirect.com/science/article/pii/0146640278900024

[33] C. Zhao and L. Zhao, "Digital nativity, computer self-efficacy, and technology adoption: A study among university faculties in china," *Frontiers in Psychology*, vol. 12, 2021. [Online]. Available: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.746292

[34] AnthologyInc, "Blackboard learn," Online: https://www.anthology.com/products/teaching-

and-learning/learning-effectiveness/blackboard-learn, 2023, accessed: 2023-05-12.

[35] European Parliament and Council of the European Union, “Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation),” https://data.europa.eu/eli/reg/2016/679, accessed: 2023-11-02.

[36] Austrian Parliament, “Bundesgesetz über Fachhochschulen (Fachhochschulgesetz – FHG),” https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10009895, accessed: 2023-11-02.

[37] Moodle, “Moodle - latest release,” Online: https://download.moodle.org/releases/latest/, 2024, accessed: 2024-10-03.

[38] ——, “Moodle - installing moodle,” Online: https://docs.moodle.org/403/en/Installing_Moodle, 2024, accessed: 2024-10-03.

[39] ——, “Moodle - apache,” Online: https://docs.moodle.org/403/en/Apache, 2024, accessed: 2024-10-03.

[40] ——, “Moodle - postgresql,” Online: https://docs.moodle.org/403/en/PostgreSQL, 2024, accessed: 2024-10-03.

[41] C. Ltd., “Ubuntu - how to install and configure and configure php,” Online: https://ubuntu.com/server/docs/programming-php, 2024, accessed: 2024-10-03.

[42] Moodle, “Moodle - feedback faq,” Online: https://docs.moodle.org/4x/sv/Feedback_FAQ, 2024, accessed: 2024-14-04.

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Appendix

A Randomizer

```
import csv
import random

# Define Likert scale labels
likert_labels = ['Strongly Disagree', 'Disagree', 'Neutral', 'Agree', 'Strongly Agree']

# Define function to generate weighted Likert scale values
def generate_weighted_likert_value(survey_number):

    # Adjust weights based on survey number (assuming increasing satisfaction)
    weights = [1, 2, 3, 4, 5]  # Initial weights
    for i in range(survey_number - 1):

        # Increase weights for higher satisfaction levels for consecutive surveys
        weights = [weight + 1 for weight in weights]

        # Generate weighted Likert value
    return random.choices(range(1, 6), weights=weights)[0]

# Generate random Likert scale data for each question, student, and survey
data = []
for survey in range(1, 4):
    for student in range(1, 31):
        student_name = f'student{student:02d}'
        for question in range(1, 10):  # Modify range to 10 for 9 questions
            likert_value = generate_weighted_likert_value(survey)
            likert_label = likert_labels[likert_value - 1]
            data.append([survey, student_name, f'Question {question}',
```

```
    likert_value, likert_label])

# Save data to CSV file
csv_filename = 'likert_scale_data.csv'
with open(csv_filename, 'w', newline='') as file:
    writer = csv.writer(file)
    writer.writerow(['Survey', 'Student', 'Question', 'Likert Value', 'Likert
    Label'])
    writer.writerows(data)

print(f'Data has been saved in {csv_filename}.')
```

Listing 1. randomizer.py

B CSV Improver

```
# Create the data matrix
data <- matrix(c(
  1, 6, 7, 7, 9,
  2, 5, 5, 7, 11,
  4, 4, 4, 12, 6,
  4, 5, 6, 7, 8,
  3, 6, 10, 7, 4,
  0, 2, 4, 10, 14,
  0, 4, 4, 12, 10,
  2, 2, 6, 11, 9,
  0, 5, 7, 8, 10
), nrow = 9, byrow = TRUE)

# Assign row and column names
rownames(data) <- c("PEOU", "PEOU", "PU", "PU", "IQ", "IQ", "SyQ", "CSE", "CSE")
colnames(data) <- c("Strongly Disagree", "Disagree", "Neutral", "Agree", "
    Strongly Agree")

```

```r
# Calculate row sums and divide by 30
final_calculation <- rowSums(data * col(data)) / 30

# Combine data matrix and final calculation result into one matrix named "survey1"
survey1 <- cbind(data, Final_Calculation = final_calculation)

# Define the file name for CSV
csv_file_name <- paste0("survey1.csv")

# Save the combined matrix as a CSV file
write.csv(survey1, file = csv_file_name)

# Confirming the file has been saved
cat("CSV file saved as:", csv_file_name, "\n")
```

Listing 2. survey1.R

C Evaluating Data

```r
# Load necessary packages
required_packages <- c("ggplot2", "patchwork")
install_missing_packages <- required_packages[!(required_packages %in% installed.packages()[,"Package"])]
if (length(install_missing_packages) > 0) install.packages(install_missing_packages)
sapply(required_packages, require, character.only = TRUE)

# Define CSV file names
file_names <- c("survey1.csv", "survey2.csv", "survey3.csv")

# Initialize a list to store Student Satisfaction values
student_satisfaction_values <- numeric()

```

```
# Function to add new rows
add_new_rows <- function(data, identifier, count, final_calculation) {
    new_rows <- data.frame(
    X = rep(identifier, count),
    Strongly.Disagree = 0,
    Disagree = 0,
    Neutral = 0,
    Agree = 0,
    Strongly.Agree = 0,
    Final_Calculation = final_calculation
    )
    return(new_rows)
}

# Create a list to store data frames for each survey
survey_data <- lapply(file_names, function(file) {
    # Import CSV data
    data <- read.csv(file)

    # Set Final_Calculation based on survey file
    final_calculation <- if (file == "survey1.csv") 3 else if (file == "survey2.
    csv") 4 else 5

    # Append new rows for 'SvQ' and 'SyQ'
    data <- rbind(data, add_new_rows(data, "SvQ", 3, final_calculation), add_new
    _rows(data, "SyQ", 2, final_calculation))

    # Calculate mean if multiple rows with the same label
    data <- aggregate(Final_Calculation ~ X, data, mean)

    # Provided coefficients
    coefficients <- c(0.124, 0.169, 0.154, 0.266, 0.128, 0.190)

    # Extract values from data
    extracted_values <- sapply(c("PEOU", "PU", "IQ", "SyQ", "SvQ", "CSE"),
    function(label) {
```

```
        data[data$X == label, "Final_Calculation"]
    })

    print(extracted_values)

    # Calculate Student Satisfaction
    student_satisfaction <- (-0.076) + sum(coefficients * extracted_values)

    print(student_satisfaction)

    # Store Student Satisfaction value
    student_satisfaction_values <<- c(student_satisfaction_values, student_
    satisfaction)

    # Store data frame in the list
    return(data)
})

# Combine data frames for each survey
combined_data <- do.call(rbind, survey_data)

# Add a column for Survey
combined_data$Survey <- rep(paste("Survey", 1:length(file_names)), each = nrow(
    combined_data) / length(file_names))

combined_plot <- ggplot(combined_data, aes(x = X, y = Final_Calculation, fill =
    Survey)) +
    geom_bar(stat = "identity", position = "dodge") +
    labs(title = "", x = "Factors", y = "Likert Scale (1-5)") +
    theme_minimal() +
    ylim(0, 5) +
    theme(axis.text.x = element_text(angle = 45, hjust = 1, size = 20), # Set x-
    axis text size
        axis.text.y = element_text(size = 20), # Set y-axis text size
        axis.title.x = element_text(size = 20), # Set x-axis title size
        axis.title.y = element_text(size = 20), # Set y-axis title size
```

```
        legend.text = element_text(size = 20), # Set legend text size
        legend.title = element_text(size = 20), # Set legend title size
        plot.title = element_text(size = 20)) # Set plot title size

# Save combined plot as a JPG image
ggsave("combined_survey_plot.jpg", plot = combined_plot, width = 10, height = 8,
     dpi = 300)

# Create a data frame for Student Satisfaction evolution
ss_evolution <- data.frame(Survey = paste("Survey", 1:length(file_names)),
    Student_Satisfaction = student_satisfaction_values)

# Remove rows with missing values or values outside the scale range
ss_evolution <- ss_evolution[!is.na(ss_evolution$Student_Satisfaction) & ss_
    evolution$Student_Satisfaction >= 3 & ss_evolution$Student_Satisfaction <=
    5, ]

ss_plot <- ggplot(ss_evolution, aes(x = Survey, y = Student_Satisfaction)) +
    geom_bar(stat = "identity", fill = "skyblue") +
    labs(title = "", x = "", y = "Likert Scale (1-5)") + # Updated y-axis label
    theme_minimal() +
    ylim(0, 5) + # Set y-axis limits
    theme(axis.text.x = element_text(angle = 45, hjust = 1, size = 20), # Set x-
    axis text size
        axis.title.x = element_blank(), # Ensure x-axis label is removed
        axis.title.y = element_text(margin = margin(t = 0, r = 20, b = 0, l = 0)
    , size = 20), # Adjust y-axis label margin and size
        axis.text.y = element_text(size = 20), # Set y-axis text size
        legend.text = element_text(size = 20), # Set legend text size if
    applicable
        legend.title = element_text(size = 20), # Set legend title size if
    applicable
        plot.title = element_text(size = 20)) # Set plot title size if
    applicable

# Save combined plot as a JPG image
```

```
105 ggsave("student_satisfaction_evolution.jpg", plot = ss_plot, width = 8, height =
        6, dpi = 300)
```

Listing 3. surveytotal.R