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Supporting Digital Self-Assessment through Universal Design for Learning (UDL)

(Instructor's Reflective Practice in a Graduate Course in Higher Education)

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ABSTRACT

This study aims to focus on the process of UDL implementation and the reflective practice of an instructor based on the collaborative work with the researcher (author of this paper) when redesigning a graduate course in a face-to-face and Blackboard (Bb) environment in a higher education university. Participatory action research was employed to document the design of a UDL course using multiple instruments. Three experts evaluated the course and its adherence to UDL framework both in Bb and face-to-face classrooms using the UDL Observation Measurement Tool (UDL-OMT). Forty-three students filled out a survey about their perceptions of the course and whether it aligned with UDL principles. Students' reflections on how the UDL course influences their success in the course were collected after the course had ended. Experts found that UDL implementation was more prevalent in a Bb environment than in a face-face environment. Students indicated that digital self-paced ungraded self-assessments were the most useful strategy, and that the action and expression principle was the most prevalent in the UDL designed course. Qualitative analysis revealed five themes that illustrate students' positive perceptions of how the UDL course influenced their success such as increased comprehension, reduced stress & anxiety, democratised culture of learning, diverse learning pathways, and disambiguated learning arena. This study contributes to fill the gap of applying action and expression principles using digital technology and self-paced and ungraded self-assessments besides other useful strategies. Future research and recommendations in light of the results are explained in the study.

Keywords: Universal Design for Learning (UDL), Self-assessment, Representation, Action and Expression, Engagement, Blackboard, Learning environment, Action Research.

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1. Introduction

Inclusive education has become a vastly significant aspect of educational systems around the world, as learners' variability in disability, preferences and cultural backgrounds are accelerating in learning spaces. As both traditional and online learning settings continue to promote inclusive education, higher education faculty and researchers nationwide have embraced and advocated for the Universal Design for Learning (UDL) framework (CAST, 2018). UDL is a proactive evidence-based framework that intends to guide the design of flexible and accessible learning environments for the purpose of meeting all learners needs (Meyer et al., 2014). Instructors and designers can enhance learners' outcomes by applying the three main principles of UDL when articulating instructional goals, selecting strategies, materials and designing assessments.

The growing body of literature on UDL implementation in higher education and the positive findings they reflect show there is a lack of studies exploring how technology can enhance the principles of Engagement and Action & Expression (Bray et al., 2024). Specifically, there is limited evidence on how digital tools can support students in developing self-regulation and self-assessment skills within a UDL framework (Boothe et al., 2020; Gawronski et al., 2016). Most efforts have centred around the Representation principle (Cumming & Rose, 2022; Fidalgo & Thormann, 2017), with less focus on Expression and Engagement or how UDL implementation affects student outcomes (Bray et al., 2024; Flood & Banks, 2021). Thus, this study aims to focus on the practical implementation of UDL in a graduate course, by illustrating the collaborative efforts between the instructor and the researcher (the principal author) using participatory action research where the instructor reflected on how and in what ways they redesigned the course in both the face-to-face and online environment. This study also contributes to fill the gap of applying more guidelines and checkpoints of engagement and expression principles through the use of digital technology and self-paced and ungraded self-assessments besides other useful strategies.

2. Theoretical Framework and Literature Review

2.1 Universal Design for Learning Framework

UDL is a comprehensive framework that stems from neurosciences, instructional design practices, and the field of learning science, and which fosters the implementation of robust strategies and approaches to enhance learner achievement (Center for Applied Special Technology -CAST, 2018; Smith, 2012). UDL transfers the learning environment from a one-size-fits all space to an inclusive and responsive arena where learners take responsibility for their learning and choose their preferred meaningful path from flexible and multiple options. UDL takes the variability of learners in the classroom into account when proactively and intentionally designing how each student is going to take part in the learning process, including special needs students (CAST, 2018; Meier & Rossi, 2020). Since 1980, UDL has been coined by

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the American organisation CAST as a pedagogical framework that refines instructional strategies through empirical research on human learning processes (CAST, 2018).

In its essence, UDL provides a systematic plan for laying down learning outcomes, strategies, materials, and assessments that fit all learners in a way that could be customisable according to every student's needs. There are three predominant principles of UDL: Provide multiple means of Representation; provide multiple means of Engagement; and provide means of Action and Expression. CAST designed the UDL framework along with its corresponding guidelines, presenting them in a graphic organiser (CAST, 2024). This organiser visually represents the framework's structure, outlining its three core principles, nine guidelines, and 31 checkpoints (CAST, 2018). These three principles listed guidelines and specific checkpoints to guide instructors and designers in structuring accessible environments for learning. However, these guidelines and checkpoints are not all mandatory to be implemented within course design, and instructors and designers are free to select what best suits their design and the level of inclusivity they would like their teaching to reflect (CAST, 2018). The following section explains each UDL principle.

2.1.1 Provide Multiple Means of Representation

Recognition networks facilitate the perception and comprehension of information, encompassing the "What" aspect of how learners process presented content (CAST, 2018). For instance, some learners may engage with information through diverse linguistic backgrounds and cultural origins, and some learners may experience sensory impairments. To mitigate these obstacles, this principal advocates for the use of multimodal instructional approaches, such as PowerPoint slides, text to speech resources, videos with captions, and translation options.

2.1.2 Provide Multiple Means of Engagement

Based on the affective network, learners are supported by offering them options to be motivated and engaged in their learning environment (CAST, 2018). Processing information and delivering learning is supported by providing alternative methods for learners to engage in tasks. These alternatives may include working in class activities and assignments collaboratively or individually. The goal of implementing this principle is to take advantage of "why" learners should do this learning task, and to trigger their motivation, interest, and self-regulation skills.

2.1.3 Provide Multiple Means of Action and Expression

The strategic network is exploited to provide learners with the autonomy and flexibility to determine "how" they showcase and communicate their learning progress (CAST, 2018). These options may include offering learners' various technological applications to produce a digital video as an assignment, or choose to

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submit either a presentation or a research report according to learners 'skills and preferences.

2.2 UDL Implementation and Digital Self-assessment in Higher Education

Prior research of UDL in higher education varies in their purpose and scope. Some previous research examined instructors' and students' perspectives of UDL implementation within learning environments, and findings revealed high students' satisfaction for UDL regarding the availability of options and the degree of flexibility they experienced within these courses (Casebolt & Humphrey, 2023; Cumming & Rose, 2022). Other studies investigated which materials, options, or technologies within UDL courses were the most used among students (Bray et al., 2024; Casebolt & Humphrey, 2023; Fidaldo & Thorman, 2017). Another area of UDL implementation examined how students perceived the level of UDL implementation within the courses (Kumar & Wideman, 2014; Li et al., 2024; Schelly et al., 2011). Despite the slightly different goals of the above-mentioned studies, all emphasised the significant benefits of UDL implementation within their educational systems.

Although many existing researches on UDL have primarily examined its impact in higher education, there remains a gap in evidence regarding its application and practical implementation in postsecondary education within developing countries (Bray et al., 2024). For example, Alquraini and Rao (2018) explored Saudi special education teachers' level of understanding and awareness of UDL, and the results emphasised the need for more training, better access to technology and resources, and extra time for lesson planning. The biggest obstacles teachers encountered were overcrowded classrooms and the absence of well-defined yet adaptable policies that align with UDL principles and its implementation. In addition, Bin Jwair and Al-Harthy (2023) investigated the degree to which instructors and students at Prince Sattam bin Abdulaziz University believe UDL principles have been integrated into online courses. They came to the conclusion that instructors were successful in implementing some of UDL guidelines and checkpoints, which reflected in students' high participation and interaction in UDL classes. The authors recommended that digital assessments should be included within the course assessment.

The majority of previous studies have primarily focused on applying the Representation principle (Casebolt & Humphrey, 2023; Fidalgo & Thormann, 2017) which is considered a quick and easy accomplishment compared to Expression and Engagement. A recent systematic review of studies that used technology to support the UDL implementation revealed that many studies have placed less emphasis on Engagement and Action & Expression, while primarily focusing on the UDL principle of Representation (Bray et al., 2024). The authors concluded that Engagement and Expression principles should be harnessed using technologies to support students' self-regulation and design self-assessments in the learning environment and ensure a well-implemented UDL course design for inclusive and accessible learning.

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Covid-19 sparked situation whereby learning modalities transferred from physical classrooms to virtual or hybrid ones. Such situation resulted in several opportunities and challenges for designers and instructors. Since then, researchers have started to investigate the possibility of implementing UDL by integrating technology to achieve more flexible and accessible environments (Basham et al., 2020; Hu & Huang, 2022). It is well-known that UDL implementation does not require technology integration; however, findings from Bray et al.'s (2024) review indicate that technological tools can significantly enhance inclusivity in various aspects of teaching and learning for all students. Using technological tools, instructors could harness them to provide students with various options to engage and express their learning. For instance, it could be supportive to create self-paced, digital self-assessment for students. The lack of emphasis on self-assessment and self-regulation strategies has been echoed in the literature (Bray et al., 2024; Bell, 2023), as the majority of students struggle with traditional assessment methods. A previous study investigated faculty and student perspectives on inclusive teaching practices in a community college using an inventory. The results revealed that students valued these practices; however, instructors rarely applied amendments and changes in course strategies and hardly ever transferred assessments into inclusive versions (Gawronski et al., 2016). Thus, it is vastly beneficial for instructors and designers to apply "digital-UDL" to support engagement and expression practices for a more inclusive and flexible learning environment.

3. Research Questions

1. To what extent does the course implementation of UDL differ between classroom and Blackboard environment according to experts' observations?
2. To what extent does the design of the course align with UDL principles according to students' perceptions?
3. What is the relationship between UDL principles according to students' perspectives?
4. How does the UDL implementation influence students' success in the course?

4. Methodology

This research employed mixed methods participatory action research methodology with the instructor reflecting on her own practice before and after implementing UDL principles in a graduate course. This methodology encompasses a systematic approach that allows practitioners to iteratively evaluate and refine their teaching practices for the purpose of achieving optimal inclusivity in learning environments. Some of the core features of action research are that it places its focus on taking actions, the reflexivity of practitioners, and the influence of the change occurring as a result of the partnership and involvement (Bradbury-Huang, 2010). Practitioners are always involved in action research as collaborators in the generation of new knowledge.

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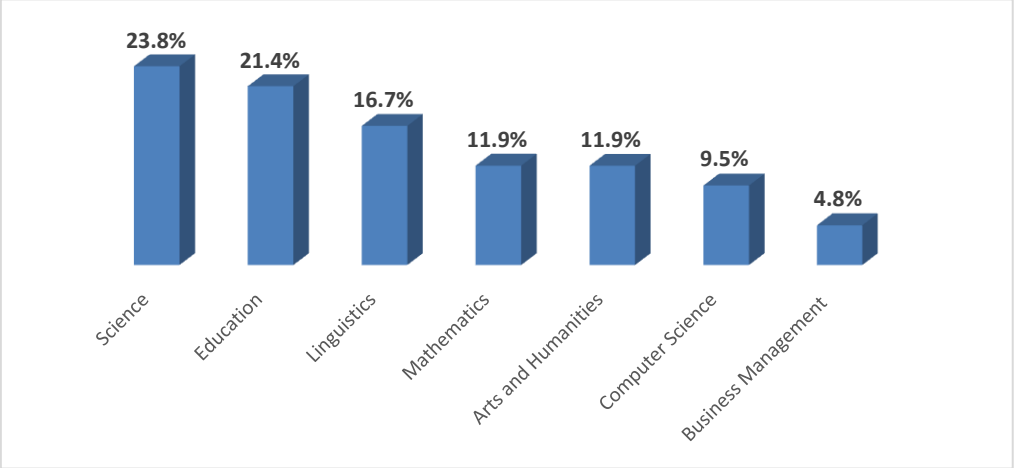
The aim of this reflective practice is to examine the effectiveness of the "E-learning Software Production "course re-engineered with UDL at a Saudi university. This experience was a collaboration between the author of this research and the instructor to scrutinise her instructional methods in the learning environment using a UDL framework. Before engaging in this research, the instructor has not previously implemented UDL in her teaching.

4.1 Participants

Participants of this study were experts from faculty members at the university and students enrolled in two sections of the graduate course taught by the instructor. Three experts in inclusive and accessible learning environments participated in observing and evaluating the course design adherence to UDL principles. Forty-three graduate students enrolled in the course in Spring 2024. Figure 1 below show the participants' demographics in terms of undergraduate specialisation.

Figure 1. Students Distribution by Speciality



The specialisation distribution of participants, as shown in Figure 1, indicates varied specialisations where the majority belonged to Science (23.8%), followed by those who studied Education (21.4%) and then Linguistics (16.7%). The percentage of students from both Mathematics and Arts & Humanities are the same (11.9%), followed by (9.5%) of the sample who studied Computer Science and finally only (4.8%) students belonged to Business Management. This suggests that respondents in this study were comprised from various and homogeneous majors wherein more than half of the participants belonged to Science, Education, or Linguistics.

The majority of participants are aged 25 and above, with 48% falling within the upper age group from 40-59, and 47% of students aged 25-39 years old, and only 5% in the youngest group aged 18-24 years old. This suggests that the participants' sample largely consisted of conventional graduate-age students. This may have implications

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for the study findings as regarding the perspectives of graduate students, their learning preferences, and their adaptability to UDL practices.

4.2 Data Collection Instruments

This research collected multiple sources of quantitative and qualitative data from the instructor, experts, and students. Data collected from participants include: 1) instructor's reflective practice about her teaching style, 2) experts' observation and evaluation of course adherence to UDL principles in face-to-face and Bb environments using the UDL Observation Measurement Tool (UDL-OMT) (Basham et al., 2020); 3) surveys on students' perspectives of UDL course; and 4) students' reflections after the learning experience. UDL-OMT tool has been proved to have a high degree of adaptability to be used in different contexts (Gäng-Pacifico & Rusconi, 2024).

This survey was basically adapted from CAST's (2011) list of UDL checkpoints, and from previous studies (Kennette & Wilson, 2019; Kumar & Wideman, 2014). The final survey consisted of three parts. The first part is about students' perspectives of the degree of alignment of the course design with UDL principles and consists of 28 statements corresponding to the UDL's three main principles (Representation, Engagement and Expression). These statements were rated on a scale from 1 to 5 (Not at all, A little bit, A moderate amount, A lot, and Unsure) where students indicated how much of the UDL checkpoint have experienced in the course and how much their instructors have applied it. The second part represents students' rating of the course's educational resources and those which they accessed and assesses the usefulness of these materials in supporting their studies. The third part, which contains eight statements, requires students' perception of course strategies and for them to specify whether they had a positive impact (supported your success), a negative impact (obstructed your success), or no impact (had no effect).

4.3 Research Procedure

The research was conducted during the spring 13-week semester. The reason for choosing this graduate course to be redesigned is that students often describe it as difficult and monotonous in content, an important course in the academic programme but requiring practical practice and relevance to their daily life. As a result, and based on UDL framework orientation sessions with the researcher, the instructor engaged in the process of redesigning the course content, transforming teaching strategies, and assessment methods through a reflective practice before the UDL makeover. The study is conducted through four phases as shown in Figure 2 and explained as follows.

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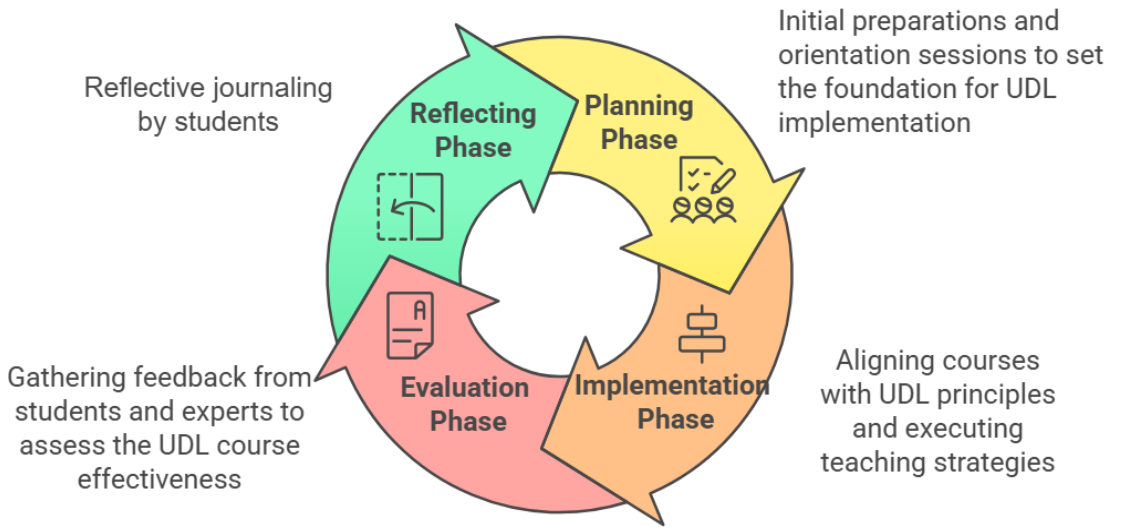

Figure 2. Action Research UDL Cycle

4.3.1 Planning Phase

In this phase, the instructor documented and reflected (in written format) on her traditional teaching practices used in this course before being introduced to UDL framework. The instructor reflected that this course was taught previously by the with a traditional syllabus and PowerPoint slides only, and all instruction and assessment methods designed were based on the instructor preferences (traditional). Accordingly, the course was not inclusive and offered little if no options for representation, expression, and engagement of students. Then, two UDL orientation sessions were presented to the instructor, followed by a reflective interview with the researcher about the ways in which the course was going to be redesigned. The researcher is an expert in using UDL framework and has employed it in various courses.

The outcome of the instructor interview and several informal conversations with the researcher underscored the instructor's clear understanding that UDL could act as the overarching instructional design model. This initial phase practically begins by identifying the course learning objectives, as well as the students' varied needs and requirements. According to Rao et al. (2018), defining learner variability and the learning environment helps in identifying potential barriers and solutions. Table 1 is the outcome of the instructor's effort to plan the UDL course in this phase based on the UDL reporting criteria (UDL RC) (Rao et al., 2018., 2020).

Table 1. Adapted UDL Reporting Criteria Analysed by the Instructor (Rao et al., 2018)

	UDL-RC element	Instructor's analysis
1	Learner Variability	• Students possess intermediate level of self-regulation skills • Students have varied levels of technological skills • Students have low level of instructional design skills

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		• Students are mostly visual learners • Most students have intermediate English language skills • Students have special interests in learning how to use new technological tools • Students may need structure and guidance to succeed
2	The Learning Environment	• Inclusive face-to-face classroom and online environment - Blackboard (LMS) • Software Production course in E-learning and distance education master programme
3	Proactive and Intentional Design	• Course goal: By the end of the course, students will be skilled in designing, developing and evaluating e-learning content that meets diverse learner needs based on instructional design skills • Students need knowledge in learning theories and pedagogical teaching and learning strategies • Barriers are the complexity of the curriculum, the authoring and production of the e-learning course, students' average learning potential and educational outcomes

4.3.2 Implementation Phase

The implementation phase involves the operationalisation of UDL principles based on the ways in which the instructor implemented its principles in the course, which is illustrated in Table 2. This step was essential in order to elucidate the process of making her design decisions concerning UDL principles, and to implement UDL strategies based on her learners' needs and the effects on her students and learning outcomes (Rao et al., 2019). The instructor aligned the course learning goals, teaching strategies and assessment methods with UDL principles and checkpoints with the aim of satisfying her students' needs and variability as well as to enhance learners' achievement and engagement in this course. After the researcher's several conversations and discussion with the instructor, and the instructor with her students, the alignment process was finalised as in Table 2.

Table 2. UDL Software Production Course Aligned to UDL Framework

UDL Principle	**UDL Software Production Course features, guidelines, and checkpoint**		**Materials explained**
	Classroom environment	**Online environment**	
Representation principle: Options for multiple ways to represent new content	a. *Options for Perception (1):* (1.1): Customised videos with closed captioning and sign language. (1.2) Various forms of course materials such as	*a. Options for Perception (1):* (1.1): Customised videos with closed captioning and sign language. (1.2) Various forms of course materials such as power point slides, images, graphic	25 videos (10 videos for the theoretical part of the course, and 15 videos for the practical part of the course*).* Three graphic

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	power point slides, images, graphic organisers, and videos are employed in the teaching process to present and deliver course content. (2.3) Offer syllabus with an outline.	organisers and charts, voice notes, videos, text documents such as research papers on the topic are employed in the teaching process to present and deliver course content. (2.3) Offer syllabus with an outline. *Options for Building knowledge (3):* (3.1) Used concept maps to connect relevant prior knowledge.	organisers, two infographics, five text research papers, three concept maps, three charts, and four voice recordings/podcasts. Text course outline with hyperlinks and illustrations.
Expression principle: Options for multiple ways students can express what they know	a. *Interaction (4):* (4.1) Flexibility in assignment deadline submission (two deadlines for each assignment), options to choose questions for formative and summative tests from pool of questions (choose three out of eight questions). (4.2) Offered multiple tools submitting assignments (authoring tools such as Articulate Storyline, ISpring Suite, and Adobe Captivate.) b. *Action & Expression (5):* (5.3) offered options for the type of assignments to be submitted (text report or visual presentation).	*Interaction (4):* (4.1) Flexibility in assignment deadline submission (two deadlines for each assignment), options to choose questions for formative and summative tests from pool of questions (choose three out of eight questions). (4.2) Options for technological tools were encouraged to be used with guidance such as ChatGPT, Grammarly, and scenario builders. c. *Action & Expression (5):* (5.3) Ungraded self-assessments with automated feedback were gradually released during the course with increasing students' independence and skills. c. *Strategy Development (6):* (6.4) Rubrics with sufficient details were used for each assignment as well as models and examples were provided for the best practices to write the assignments.	(4.1) All three assignments had two deadlines, and two course exams had the options to choose questions to be answered based on students' interest and knowledge. (4.2) Different options for authoring tools and scenario builder tools and technological tools such as generative AI tools were offered. (5.3) Three ungraded self-assessments with automated feedback were deployed. Choice offered on students' way of expressing learning in assignments (text report, or visual presentation) (6.4) Rubrics, assignment examples or models were provided for each course assignment.
Engagement principle: Options for multiple ways students can engage in	a. *Welcoming interests & identities (7):* (7.2) Offering choice of topic according to students' interest when completing projects	d. *Welcoming interests & identities (7):* (7.1) Offered choices for: course content to explore. (7.2) Offering choice of topic according to students' interest	(7.2) Students chose topic of assignments (two course assignments) (9.3) Students chose

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practice of new content	b. *Sustaining Effort & Persistence (8): (8.3)* Encourages collaboration and collective learning in the course during multiple activities. c. *Emotional Capacity (9): (9.1)* Employ activities that encourage self-reflection and appreciation of one's strength (project report and self-reflection). (9.3) Adopt options for students to work collaboratively or individually in class activities.	when completing projects. *Sustaining Effort & Persistence (8):* *(8.5) O*ffering timely and informative feedback on tasks. e. *Emotional Capacity (9):* *(9.1)* Employ activities that encourage self-reflection and appreciation of one's strength (project report and self-reflection). (9.3) Adopt options for students to work collaboratively or individually in assignments.	between working solo or collaboratively on one assignment.

As the course is taught in a blended learning environment (classroom and Blackboard), the instructor operationalises UDL principles and checkpoints by taking the environment into consideration. For example, the materials utilised to implement the UDL representation principle in the classroom consisted of accessible PowerPoint slides, images, videos, graphic organisers, and diagrams. In the Blackboard (Bb) environment, these materials were further diversified to include charts, voice notes and text documents. Bb materials were organised into folders for each lecture containing the multiple types of representations and information for supporting students' varied learning preferences. Learners' access to course content can be elevated by the incorporation of learner choice, deadline flexibility, several ways of engagement with the content, and opportunities for expressing learning, which can all promote students' access to content (Cumming & Rose, 2022). The researcher attended some face-to-face classes and observed asynchronously the online learning environment (Blackboard) during the semester. Figure 3 and 4 is an example of operationalisation of the first principle within a Bb environment.

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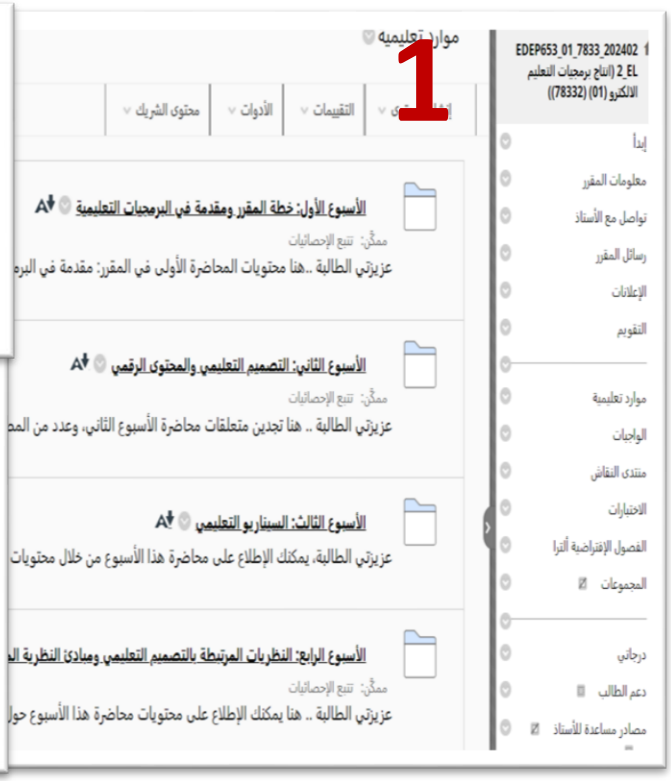
(2)Figure 3. Bb varied Material folders divided by weeks (one lecture every week)



(1)Figure 4. Example of one Bb varied materials' folder which contains (lecture learning outcomes, infographic, a website on cognitive load theory, a video, an organizer…) among other types of materials

4.3.3 Evaluation Phase:

While the instructor taught students using the redesigned course which incorporated UDL, each individual expert attended two classroom lectures at the beginning and end of the semester and evaluated the redesigned UDL course and then filled out the UDL-OMT (Basham et al., 2020). Then, each individual expert scrutinised the course in the Bb online environment in terms of the application of UDL principles and strategies and then evaluated the overall design using the UDL-OMT. Thus, each expert evaluated the course in the two environments (classroom and Bb), ending up with six filled out observations. By the end of the course, students were asked to complete a students' perspectives survey about the extent of the course adherence to UDL principles and checkpoints. Before administering the questionnaire to the target participants, eight students from another graduate programme filled out the questionnaire to test the validity and reliability of the survey.

4.3.4 Reflection Phase:

When the students had completed the course requirements, they were asked to prepare a written reflection about their opinions of this course in general. In the same line, the

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researcher asked the instructor to write a reflection on this teaching and learning experience. Students' reflections were thematically analysed according to Braun and & Clarke (2012) approach.

4.3.5 Data Analysis

To ensure the validity and reliability of the students' survey, two steps were employed. First, a panel of reviewers scrutinised the survey and provided their feedback, and their comments were carefully analysed and incorporated into the instrument to refine statement clarity and relevance. Second, statistical reliability and validity tests were conducted to assess the survey's consistency and construct validity. Cronbach's alpha test was used to measure the reliability of students' survey responses, where the value of alpha was 0.873, which is an excellent percentage being higher than the acceptable ratio (0.60), and the values of alpha for the study dimensions are also higher than the acceptable ratio, which is shown in Table 3.

Table 3. Reliability Test Results for Students' Perspectives on UDL Course According to UDL Principles

UDL Principle	α value
Representation	0.664
Engagement	0.787
Expression	0.779
Overall	0.873

Pearson correlation coefficient was used to measure the internal consistency which is the extent to which each statement relates to its own component/dimension. The results indicate that all coefficients are statistically significant, with P-value<0.01. This suggests a strong level of validity in the statements related to their respective UDL principle as shown below in Table 4. Data analysis in this study was calculated using IBM SPSS v27.

Table 4. Correlation Coefficients of Course Design Statements with their Respective Dimension (Students)

Component / Dimension	Statement Number	Pearson's correlation coefficient
Representation	1.	0.656**
	2.	0.602**
	3.	0.748**
	4.	0.531**
	5.	0.612**
	6.	0.512**
	7.	0.512**

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Engagement	8.	0.410**
	9.	0.398**
	10.	0.544**
	11.	0.555**
	12.	0.522**
	13.	0.561**
	14.	0.665**
	15.	0.584**
	16.	0.501**
	17.	0.419**
	18.	0.712**
	19.	0.594**
	20.	0.617**
	21.	0.665**
	22.	0.646**
Expression	23.	0.627**
	24.	0.811**
	25.	0.811**
	26.	0.811**
	27.	0.804**
	28.	0.753**

* Significance level < 0.05

** Significance level < 0.01

As for the experts' UDL-OMT evaluation tool which was employed to answer the second research question, mean scores and standard deviation were calculated for each UDL principle in each environment, and the overall mean and standard deviation for each environment and the level of UDL use was identified. The quantitative data for students' survey were first analysed by calculating descriptive statistics, and Related-Samples Friedman's Two-Way ANOVA by ranks was used since the data were not normally distributed, to test the difference between students' scores in the three dimensions of UDL. Also, Pearson correlation was employed to uncover the relationship between UDL principles according to students' perspectives based on the survey. Finally, thematic analysis was used to analyse students' reflections after completing the UDL course.

5. Results and Discussion

This section presents the results and discussion of the instructor's implementation of UDL principles based on the experts' observations and students' perspectives from both the survey and reflections.

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5.1 Expert Course Evaluation Using UDL-OMT

This subsection answers the research question: To what extent does the course implementation of UDL differ between classroom and Blackboard environment according to experts' observations?

Since the UDL-OMT tool used a rating scale of 3, the degree of UDL implementation observed across the environment based on experts' evaluation was defined as shown in Table 3. Results show that all course design components for the Classroom environment were rated as Emergent, while all components were rated as Observed for Blackboard environment. Thus, it appears that experts observed the instructor to practice consistent, visible applications of UDL principles within the LMS learning context. This was evident in documented learning content, extracurricular materials, recorded lectures, and periodic self-assessments. On the other hand, experts' ratings suggest that the instructor's application of UDL principles within the classroom face-to-face environment was not as obvious and consistent. Experts suggest that although the instructor showed some UDL teaching practices during lectures, these practices were rare, disorganised, and insufficient throughout the lecture. Results of experts' evaluation of the UDL course are shown in Table 4.

Table 3. Approval Level for Scale of 3 – Expert's UDL-OMT

Average of scores	Level of UDL use	Characterisation
1–1.66	= Pre-emergent	UDL was not observed beyond naturally occurring instructional practices.
1.67–2.33	= Emergent	UDL was observed, but it was not necessarily applied consistently during the observation.
2.34–3	= Observed	UDL was obvious and being consistently applied.

Table 4. Experts' Course Evaluation using UDL-OMT for each UDL Course Dimension

Component / Dimension	Method	Mean	SD	Approval Level
Representation	Classroom	1.667	0.401	Emergent
	Blackboard LMS	2.556	0.111	Observed
Engagement	Classroom	2.185	0.128	Emergent
	Blackboard LMS	2.481	0.170	Observed
Expression	Classroom	1.952	0.360	Emergent
	Blackboard LMS	2.810	0.082	Observed

SD: Standard Deviation

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It can be argued that the instructor's limited familiarity and exposure to UDL principles within the classroom environment can be attributed to the novelty of these inclusive and flexible pedagogical strategies as opposed to the traditional and structured methods. Thus, the instructor may be struggling to deviate from her comfort zone of conventional teaching practices. This is previously echoed in the literature where the successful pedagogical teaching momentum will prevent the transition to a more flexible, student-centred approach (CAST, 2018; Meyer et al., 2014). The literature indicates the difficulty of the pedagogical shift, highlighting the conflict that exists between the theoretical appeal of UDL-based practices and the realities of teaching changes. Despite the growing calls for adopting UDL practices, educators and teachers tend to return to the pedagogical practices which provided them with educational satisfaction. Thus, educational institutions need to invest in professional development to support the smooth educational practices transfer to a UDL framework.

5.2 Students' Perspectives of the Extent of UDL Principles Course Implementation

This subsection answers the research question: To what extent does the design of the course align with UDL principles according to students' perceptions?

Since the survey used a rating scale of 5, the degree of UDL implementation perceived by students was defined as shown in Table 5, which illustrates the approval level for a scale of 5 of the students' survey.

Table 5. Approval Level of Students' Survey Scores - Scale of 5

Mean Score	Approval level
1-2.33	Poor level
2.34-3.67	Intermediate level
3.68-5	High level

According to students' perspectives on the degree of UDL implementation of the course, Table 6 shows the results which illustrate that the level of approval for all three UDL course principles are high. Related-Samples Friedman's Two-Way ANOVA by ranks has been used since the data were not normally distributed to test the difference between students' scores in the three dimensions of UDL - Representation, Engagement and Expression. As shown in Table 6, the highest ratings among the three UDL principles implemented in the course according to students' perspectives was Expression, followed by Representation and then Engagement. Students rated the UDL course the highest on the options provided to them and the multiple ways they are offered to express what they know during the semester. The flexibility and options for submission deadlines, the ungraded self-assessments, the option to choose among different technological tools according to students' choice,

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the detailed rubrics, and examples and models of assignments provided to students were some of the ways that the UDL course reflected the Expression dimension.

With a p-value < 0.05, the results suggest that there is a significant difference between UDL course dimensions ratings, specifically between Engagement and Expression. It can also be concluded that the Expression in the UDL course is higher than both that of Representation and Engagement. Gawronski et al. (2016) highlighted the lack of providing inclusive assessments by instructors in their courses, which may justify the high score that students rated the expression principle within this course. One of the instructor's UDL implementation strategies was incorporating online ungraded self-assessments which are offered periodically throughout the semester, and students receive automated feedback on their performance after completion. A self-assessment tool as a key component has been shown to positively influence student learning and engagement as students enjoy being offered the choice in the way they demonstrate their understanding which is an essential aspect of the Expression principle of UDL (Boothe et al., 2020).

Table 6. The Level of Students' Ratings of each UDL Principle

UDL Course Principle	Mean	SD	Approval level	Rank	P-value
Representation	4.748	0.306	High	2	0.017*
Engagement	4.744	0.236	High	3	
Expression	4.829	0.231	High	1	

SD: Standard Deviation

* Significance level < 0.05

However, a statistically significant difference was seen between Engagement and Expression of the UDL course dimensions according to students' ratings. It seems that giving students choices regarding assignment topics or working solo or collaboratively was not as appealing and motivating as the unique practice of providing ungraded self- assessments during the semester. Thus, students in this study appear to recognise the vital role in UDL, particularly in allowing them to demonstrate their understanding in different ways. This flexibility is of paramount importance in a cultural context where students may usually feel constrained by traditional assessment methods. Casebolt and Humphrey (2023) indicate that providing students with various options for expressing their knowledge can lead to enhanced satisfaction and improved learning outcomes. In addition, UDL orchestrates online learning environments that take the different learning styles of students into consideration, which eases students' challenges (Fidalgo & Thormann, 2017).

The thematic analysis resultant from students' reflections answers the research question: How does the UDL implementation influence students' satisfaction and success in the course? The analysis yielded five themes that illustrates the ways in which the UDL course impacted students' satisfaction and success. These themes are: Increased Comprehension, Reduced Stress & Anxiety, Democratised Culture of

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Learning, Diverse Pathways to Learning, and Disambiguated Learning Arena. Table 7 in the Appendix illustrates the resultant themes and examples from students' reflection about the UDL course. The explanation of these themes is triangulated with the below description of students' survey results.

Table 8 illustrates that students rated all statements in all three principles of UDL by high scores > 4.214 out of 5. The highest score value of 4.952 was identical for the statement "Make PowerPoint slides available to students" in the Engagement principle, and the three statements "Provide optional self-assessments to practise course content, adequate (or unlimited) time for tests (e.g., self-assessments, feedback on the first stage of the scenario)", "Provide rubrics (rules) for all assignments", and "Guide you in using increasingly difficult activities or tasks (guidance and feedback during scenario and project work)" in the Expression principle. The results of each UDL principle according to students' perspectives are discussed next.

Table 8. Descriptive Statistics for Students' Survey Statements

UDL Principle	Statement	Mean	SD	Rank	Approval Level
Representation	1. Delivering course content in multiple ways (e.g., files in Blackboard learning resources--images, video, text, graphic maps/concept maps, etc.)	4.740	0.445	10	High
	2. Recording e-lectures and making them available for streaming after the lecture (Blackboard video)	4.570	0.668	17	High
	3. Providing alternatives to course content for audio information (e.g., video transcripts) and visual information (e.g., image descriptions)	4.670	0.721	13	High
	4. Highlighting patterns and relationships in course content (e.g., how instructional design stages relate to each other)	4.640	0.656	15	High
	5. Publishing course content on Blackboard and making it available on the system	4.900	0.297	4	High
	6. Including subtitles on videos (closed captions)	4.786	0.470	8	High
	7. Providing clear instructions course materials and key tasks (e.g., assessment criteria for assignments, how to submit an assignment)	4.929	0.261	2	High
Engagement	8. Provide interesting and relevant key tasks or costs to the content	4.667	0.526	14	High
	9. Allow some autonomy and/or control	4.810	0.455	7	High

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	over student learning (e.g., assignment choices (group or individual, presentation or report)				
	10. Allow some autonomy and/or control over student learning (e.g., choices on tests (choose three out of five questions and answer them)	4.857	0.354	6	High
	11. Allow students to decide which topics will be covered in assignments	4.714	0.508	11	High
	12. Use hands-on activities in lecture	4.571	0.501	16	High
	13. Link course content to real-world experiences	4.691	0.468	12	High
	14. Communicate with students (in lecture, outside of lecture, via university app or email)	4.762	0.431	9	High
	15. Provide clear and specific feedback on assignments	4.881	0.328	5	High
	16. Offer a choice of how students would like to receive feedback on assignments (e.g., oral or written feedback)	4.524	0.773	18	High
	17. Allow students to resubmit assignments	4.214	0.813	20	High
	18. Make PowerPoint slides available to students	4.952	0.216	1	High
	19. Include group work and collaboration with other students (e.g., discussion forum, group projects)	4.929	0.261	2	High
	20. Provide opportunities for self-evaluation and reflection. (e.g., self-assessments, formative assessment in design)	4.905	0.297	3	High
	21. Minimise threats and distractions in the learning environment	4.762	0.431	9	High
	22. Motivate students to do their best	4.929	0.261	2	High
Expression	23. Flexible deadlines for key assignments (e.g., late submissions are allowed)	4.405	0.544	19	High
	24. Provide optional self-assessments to practice course content, adequate (or unlimited) time for tests (e.g., self-assessments, feedback on the first stage of the scenario)	4.952	0.216	1	High
	25. Provide rubrics (rules) for all assignments	4.952	0.216	1	High
	26. Guide you in using increasingly difficult activities or tasks (guidance	4.952	0.216	1	High

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	and feedback during scenario and project work)				
	27. Guide the process of setting goals and developing student learning strategies	4.929	0.261	2	High
	28. Provide opportunities for students to monitor progress (e.g., grades posted on the BB Learning Management System)	4.786	0.415	8	High

SD: Standard Deviation

5.4 UDL Principle 1: Action & Expression

The Action & Expression design principle was the most prevalent across the UDL principles that the instructor implemented and delivered throughout the course, according to students' perspectives. Students perceived the self-assessment component among the most prominent strategy in the graduate course. This shows that the instructor took advantage of the opportunity of having a blended learning environment (face-to-face and Bb) and give students the ownership of their learning processes while promoting their metacognitive skills and enhancing their autonomy. It is highly useful to offer students periodic self-assessments with automated timely feedback to inform next steps in learning and prevent possible failure (Rose et al., 2018). A common theme which surfaced from students' reflection was the "reduced stress & anxiety" that the digitised ungraded self-assessments imposed on them. Students explained how the multiple attempts available to repeat the assessment without losing grades created a safe and stress-free learning environment for them. The literature reinforces the significance of repetition which was employed by the instructor through the use of multiple attempts on Bb. This strategy of assessment repetition created greater options to master the subject (Davis et al., 2020), and improve students' comfort level (Agarwal et al., 2014; Bell, 2023).

Moreover, students were hugely satisfied and less anxious when offered the pool of questions in exams to choose from according to their mastery level. This is echoed in the literature where it suggests that limited quantity of exam questions raises the level of anxiety among students (Bell, 2023). In addition, providing continuous guidance and feedback on assignments, and listing detailed rubrics were also among the most prevailing strategies of UDL that the instructor implemented in the course. The instructor provided timely feedback on course assignments, which many students acknowledged and were elated to receive written comments on their software projects with track changes within a Word assignment.

Students praised the "diverse learning paths," as it surfaced as a theme, which they were offered throughout the course. which was evident in the flexibility in assignments deadlines, the technological tools they could pick to complete their projects, and the type of assignment they could tackle. They explained that every student was able to choose their own learning path and learn at their own pace without

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having to worry about grading or achieving learning outcomes. The control that the instructor gave students in this course over their learning resulted in the outcome of the self-pacing, multiple attempts, and timely feedback. Although there is a reluctance among instructors to embrace these strategies as they are challenging to implement effectively (Casebolt & Humphrey, 2023), these learning strategies should not be ignored.

5.5 UDL Principle 2: Representation

Among the representation strategies that the instructor employed and which were most preferred by students were the detailed weekly lectures folders posted in Bb, assessments rubrics, and the explanations on how they can submit their assignments. Such strategies were rated the highest by students. Several studies emphasised the significance of delivering concepts in multiple representations and content in various formats (Bray et al., 2024; Schelly et al., 2011). It was evident that students favoured the amount of guidance and support offered to them while navigating the multiple formats of materials in the Bb system. The instructor provided clarification for several content files, as well as useful information on how to work on their assignments and learning tasks. This continuous digital support and guidance when implementing representation principle was echoed in a recent systematic review on technology use in UDL implementation (Bray et al., 2024). Furthermore, multimedia incorporation as an alternative to the conventional lecture files is a widely used UDL practice (Daley et al., 2016; King-Sears & Johnson, 2020), which contributes to enhance students' academic performance (Brand et al., 2012). A common theme which emerged from students' reflection was "increased comprehension," where they confirmed that the various formats of content enhanced their comprehension of course concepts as the multiple files approached each concept from a different angle, contributing to greater understanding and achievement. This shows that the instructor's increased effort in representing course ideas by highlighting patterns, relationships and critical points supports students' holistic comprehension and meaningful learning (Bray et al., 2024).

5.6 UDL Principle 3: Engagement

As for the Engagement principal strategies implemented by the instructor, students preferred the ways in which they engaged with lecture materials, especially the PowerPoint slides. This is consistent with what Kumar and Wideman (2014) found in their study as students described how they could easily follow the lecture and post their notes on the slides, thus, they felt more control with their learning process. In addition, the strategies that the instructor used to motivate students were among the most preferred strategies rated by students. The instructor offered students choices to work collaboratively or individually, and offered choices of preferred topics in assignments. This surfaced in students' reflections as the theme "democratised culture of learning", wherein students articulate how these strategies impacted their success in the course as they had the freedom to choose how they can learn and engage with the

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course content and assignments. For instance, students described that they were able to plan their workload around the flexible deadlines easily. This is in alignment with previous research where students preferred choosing their own topic when completing assignments (Smith, 2012). The autonomy opportunities and options for support and feedback students were given to reflect on their learning and self-evaluate their progress at any point during their study in the course could lead to increased comprehension and reflection (Daley et al., 2020; Hitchcock et al., 2016).

The instructor's strategies in writing detailed instructions in the course files such as course outline, assignment rubrics and guiding model have contributed to their increased engagement and satisfaction with the course. This was evident within the students' quotes in the theme "disambiguous arena of learning" where students experienced the attributes of a clear and direct learning environment. This is in alignment with previous study where students explained how the consistency of the course plan and assignments' instruction reduced their frustration, and they felt that the instructor anticipated all their questions (Kumar & Wideman, 2014).

As shown in Table 9 and 10, students were asked to select from a list of the course of materials and strategies if they used them and if they found them useful. As for course materials, all students (100%) used the basic educational resources for each lecture on Blackboard and course information and guided details on all tasks were useful. Moreover, most students benefited from materials for practical application (98%), as well as the extra videos explaining further concepts in the course (95%) and found that the course strategies had a positive impact on their success. The research papers on concepts that deepen students understanding on the course related information (62%) were the least useful according to students' ratings of course materials.

Table 9. Impact of Course Resources on Students' Success.

Course Materials	Used/Seen and it's useful (%)	Never Used/Seen but it's useful (%)	Never Used/Seen and it's not useful (%)
Basic educational resources for each lecture on Blackboard.	100%	0%	0%
Posting the detailed course plan, including evaluations, assignments, and material provided from the start of the semester.	100%	0%	0%
Enrichment educational materials for each lecture: videos.	90%	10%	0%
Enrichment educational materials for each lecture: research papers.	62%	29%	9%
Enrichment educational materials for each lecture: illustrative images, maps, or infographics for	95%	5%	0%

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terminology.			
Educational materials for practical applications.	98%	2%	0%

When it comes to the favourite course strategy that impacted students' success in the course, all students (100%) indicate that lectures recordings, ungraded digital self-assessments with multiple attempts, textual guidelines, instructions on completing assignments and their rubrics, as well as choosing final exam questions from a pool of questions to answer were the strategies that particularly influenced their success positively in the course. As shown in Table 10, students also suggest that the increased flexibility regarding the type of assignment they could choose to submit (98%), the assignment models posted (95%), and the various options for deadlines to submit assignments (93%) contributed to their success in the course.

Table 10. The Impact of Course Strategies on Student Success

Course strategy	Positive Impact (%)	No Impact (%)	Negative Impact (%)
Options for assignment due dates and their flexibility.	93%	2%	5%
Recordings of digital lectures.	100%	0%	0%
Choosing the type of assignment (presentation, or report/project).	98%	0%	2%
Ungraded digital self-assessments with multiple attempts.	100%	0%	0%
Posting models for how to solve assignments at each stage.	95%	0%	5%
Textual guidelines and instructions on how to complete assignments.	100%	0%	0%
Providing detailed criteria for evaluating assignments.	100%	0%	0%
Selecting questions from a pool of questions to answer in the exam.	100%	0%	0%

5.3 Students' Perspectives of the Relationship between the Course UDL Principles

This subsection answers the research question: What is the relationship between UDL principles according to students' perspectives?

Figure 5 below shows that there is a highly significant correlation between Engagement and Expression of students in the UDL course with a strong positive Pearson correlation coefficient of 0.81. There is also a significant moderate correlation between Representation and Engagement (0.56), and between Representation and Expression. This suggests that when students are given a variety

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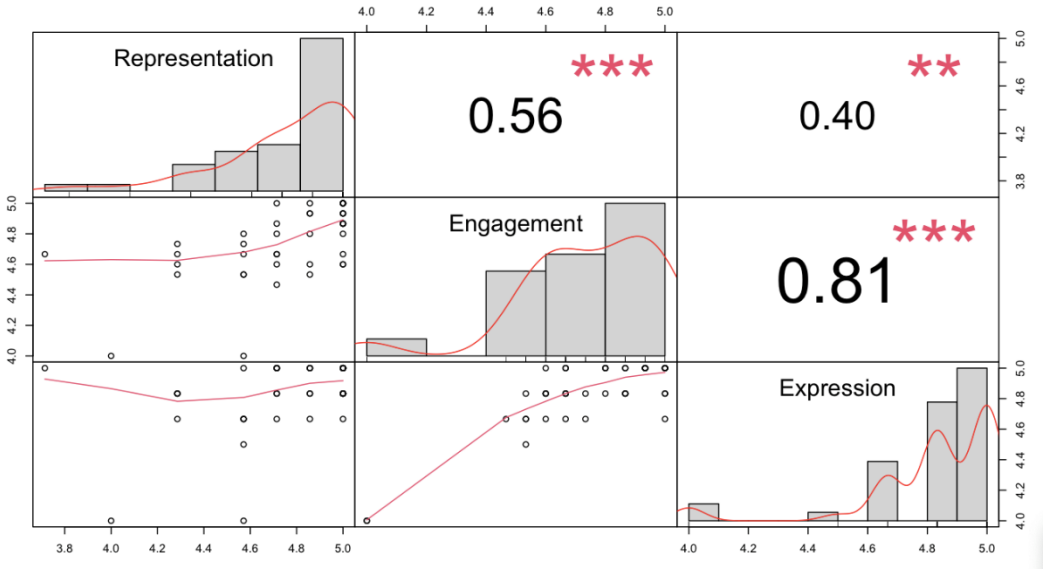
of engagement options (such as a choice of tasks or resources), they are encouraged to express their knowledge in more meaningful and varied ways. This intertwined relationship between Engagement and Expression UDL principles has come a long way in the literature (Basham et al., 2017; Rose et al., 2006). In a more recent study, which examined the correlation between Engagement and Expression within special education classrooms, Astudillo and Murren (2021) found that students provided with engagement digital venues such as interactive simulations were more inclined to utilise digital tools such as speech-to-text, visual organisers and video/audio recordings for self-expression, as opposed to conventional means of submitting assignments.

Figure 5. Correlation Matrix for UDL Principles based on Students' Perspectives



6. Conclusion

This study documents the reflective practice of an instructor redesigning their graduate course to align with UDL principles in both face-to-face and online Bb environments in higher education. The study also reports on the findings of experts and students' perspectives of the ways in which the redesigned course adheres to UDL. The findings of experts' evaluation revealed that UDL implementation was more visible and consistent with Bb learning environment compared to a face-to-face context. Deviation from traditional teaching practices can be difficult for instructors who are not familiar with UDL philosophy. Therefore, the implementation of UDL in the classroom environment comes with its challenges, and the educational systems need to tackle this issue as part of ongoing professional training. Such institutional efforts would impact a smoother transition to inclusive teaching practices.

The research suggests that students rated expression guidelines and checkpoints implemented to be the most useful and prevalent within the course, followed by Representation and Engagement. More specifically, students perceived the digital

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self-paced and ungraded self-assessment component to be the most prominent and useful strategy in the graduate course. Although students also indicated that the detailed weekly lectures folders posted in Bb, digital assessments rubrics, and the options to work collaboratively or individually were useful, these strategies were not as appealing as the digital self-assessments. It appears that Saudi students were elated with such flexibility and anxiety-free assessments as they are accustomed to educational practices that are often rigidly structured and offer limited choices regarding their engagement and ways of expression. Moreover, the strong correlation between the Expression and Engagement principles of UDL suggests that the more students are engaged in a learning environment, the more effective their expressive modalities used in the course, particularly in digital and hybrid learning environments (Basham et al., 2017). Thus, institutions, instructors and designers should meaningfully apply both principles for a successful inclusive and flexible learning. The qualitative analysis of students' reflections yielded five themes that corroborate their quantitative ratings of UDL implementation, and give deeper meaning into their satisfaction and selection of the best UDL strategies that they perceived to impact their success. Future research should expand on the use of technology with the UDL framework, with specific emphasis on expression and engagement checkpoints. Artificial intelligence systems, chatbots and such emerging technologies, if used intentionally, will provide more support and scaffolding needed to promote students' outcomes and comprehension.

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Appendix

Table 7. Themes and Students' Excerpts from their Reflections about the UDL Course

	Theme	Example from students' reflection text
1	Increased Comprehension	*"I was truly amazed at how much I enjoyed and benefited from the variety of learning materials the instructor provided each week. The combination of videos, infographics, and other resources didn't just make the content more engaging—it reinforced and deepened my understanding of key course concepts. Each format presented the material from a different angle, helping me grasp complex ideas more easily and retain the information more effectively".*
		"The ungraded self-assessments before exams were incredibly valuable. They gave me a clear sense of my understanding and showed me whether my study efforts were paying off. Being able to check my progress without the pressure of grades helped me identify areas I needed to review, making my exam preparation much more focused and effective".
2	Reduced Stress & Anxiety	*"The multiple attempts were a game-changer because each time I completed a self-assessment, I received automated feedback that helped me learn from my mistakes. Knowing that I could keep practising without the fear of losing grades made all the difference. By the time the midterm and final exams came around, I already knew what to expect—the question styles, the format, and even how to approach them. The repetition made the stress gradually disappear, and for the first time, I walked into an exam feeling confident instead of anxious".*

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		This course was completely different from any other I've taken before—I didn't feel the usual stress and anxiety leading up to exams. The multiple attempts on the digital self-assessments made a huge difference. Since they were ungraded, I didn't have to worry about my score; instead, I could focus on actually understanding the material. The automated feedback after each attempt helped me see where I stood and what I needed to improve, so by the time the midterm and final exams came around, I felt confident and prepared. Knowing I had this chance to practice without penalties took away so much pressure and made learning feel like a process, not just a test".
3	Democratised Culture of Learning	*"As I navigated through the course materials, I was in disbelief! For the first time in my life, I had so many choices and the freedom to express my opinions. I could select topics that truly interested me for assignments, and my preferences were not only acknowledged but prioritised and integrated into the learning experience".*
		"In previous courses, I often felt limited by rigid deadlines and standardised assignments that didn't always align with how I learn best. But in this course, I felt like my learning truly mattered. I could watch lectures at my own pace, choose between submitting a written report or a video presentation... The instructor encouraged discussions where every perspective was valued, and I never felt like learning style put me at a disadvantage".
4	Diverse Learning Pathways	*The final exam was a surprise for me ...I wasn't locked into answering a fixed set of questions but could instead select from a diverse pool that matched my level of understanding. Every a student could choose a path to learn in this course.. These choices didn't just make learning more convenient; they gave me ownership over how I engaged with the material, making the process more meaningful and effective".*
		This course had a great flexibility. I never felt confined to a single way of learning or demonstrating my understanding. The multiple deadlines for assignments allowed me to plan my workload based on my personal and academic commitments. I also appreciated having the choice to work individually or in a group, which gave me the freedom to select the learning approach that suited me best. Even during the final exam, I wasn't forced into a one-size-fits-all model—I could choose questions from a large pool based on my level of study, ensuring that I could truly showcase my strengths. This course redefined what learning should feel like—adaptable, inclusive, and designed for success".
5	Disambiguated Learning Arena	*"I've never had a course this well-organised before! Every time I had a question, I'd check the course materials, and the answer was already there. It felt like the instructor had anticipated every doubt I might have. I never had to second-guess what I was supposed to do—the information was always clear, and I could just focus on learning instead of figuring things out on my own".*
		"I really liked how clear the assignments were in this course. The instructions were super detailed, and I always knew exactly what was expected of me. Having an assignment model to look at made a huge difference because I could see what the final product should look like. The rubrics were also straight to the point—no guesswork, no confusion. I never felt lost".