



THE INFLUENCE OF FORMATIVE ASSESSMENT PRACTICES ON STUDENTS' BEHAVIOURAL ENGAGEMENT AND LEARNING OUTCOMES IN ONLINE HIGHER EDUCATION

Ari Kuncara Widagdo

Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta, Indonesia

Article History:

Received Date: 01/05/2026

Revised Date: 06/07/2026

Accepted Date: 10/07/2026

Published Date: 17/07/2026

Keywords: formative assessment; behavioural engagement; online higher education; learning analytics; learning outcomes

ABSTRACT

The study explored the relationship between formative assessment practices, student's behavioural engagement and learning outcomes in online higher education. Secondary data were used and a quantitative, non-experimental, correlational research design was used. There were no common student identifiers, so two datasets were statistically matched, resulting in a final analytical sample of 3,948 student-course records. The measures of formative assessment practices included assessment completion, assessment type, weighted assessment performance, and on-time submission rate. Behavioural engagement was measured in terms of virtual learning environment (VLE) clicks and active days of learning, while learning outcomes were measured using weighted scores, learning-outcome index and final course results. Descriptive statistics, one-way analysis of variance, Pearson correlations and multiple linear regression with robust HC3 standard errors were used. A total of seven or more assessments resulted in significantly more platform activity, more active learning days, higher weighted scores, and higher percentage of successful final products of the students who completed this number of assessments compared to those who completed fewer. There was also a positive relationship between on-time submission and engagement and academic performance. These relationships were also statistically significant when demographic, academic and course related characteristics were considered. The results indicate that there is a significant relationship between regular engagement in formative assessment and consistent academic achievement and between timely submission and consistent academic achievement and behavioural engagement. The study, however, was observational and statistically matched, and the findings should be viewed as associations and not causal findings.

1. Introduction

The growth of online higher education has changed the way students engage in learning, access course materials and exhibit academic achievement. Digital platforms have now made it possible for institutions to track students' activity, participation in assessment, submission behaviour and overall performance in a manner that was previously challenging. In this context, behavioural engagement has become increasingly significant as an indicator of students' active learning, as evidenced by their actions on the platform, including access to the platform, frequency of participation, submission of assessments, and interaction with online learning resources (Bergdahl et al., 2024).

Student engagement has been increasingly supported in higher education through the use of educational technology. There is existing research that suggests engagement is multi-dimensional and that digital learning environment design, instruction, evaluation, and interaction contribute to it. (Bond et al., 2020) There might be an increased level of participation when using online self-assessment activities, as this requires students to constantly practice, monitor and engage with the content of the course (Büchele et al., 2025). The delivery of online learning can also influence students' learning. Synchronous and asynchronous instruction modes offer various possibilities for participation, interaction, flexibility, and feedback, which might affect the interaction with academic tasks (Fabrizz et al., 2021). Digital formative assessment also can help teachers during the instructional process to get information on student learning difficulties, emotional reactions, and their learning understanding (Grimalt-Álvaro & Usart, 2024).

Assessment in higher education is a crucial aspect of online learning. It is effective when the assessment is well-designed, accessible, provides valid feedback, ensured of academic integrity, and aligned with desired learning outcomes (Heil & Ifenthaler, 2023). Learning analytics dashboards have also been implemented to enable students and teachers to get information on achievement, motivation, participation, and learning behaviour (Kaliisa et al., 2024). Digital formative assessment involves more than administering online tests. For the effective implementation to be possible, a coherent coordination between learning aims, assessment activities, feedback mechanisms, technological tools and student needs is required (Kaya-Capocci et al., 2022).

There is some evidence that attendance may be driven by participation and performance in formative assessments, which may account for some of the association (Lu and Cutumisu, 2022). Formative assessment can also support the agentic engagement by empowering learners to make more autonomous decisions about their learning and feedback (Zenouzagh Mohammadi et al., 2025). The number of studies on online formative assessment has grown significantly in recent years, and the growing interest in digital feedback, assessment technologies, learning analytics and student-centred

assessment (Sudakova et al., 2022) has been shown. Yet, there are technical, organisational, ethical, and pedagogical barriers to the institutional adoption of learning analytics (Tsai et al., 2020). Learning analytics can be used to identify students who are at risk and inform early intervention actions that will increase the likelihood of student success in learning (Ifenthaler & Yau, 2020). The visibility of students' progress and participation patterns can benefit self-regulated learning, as can learning analytics dashboards (Matcha et al., 2019).

Feedback oriented dashboards can be linked with observable learning behaviour to processes like planning, monitoring, reflection, and learning regulation (Sedrakyan et al., 2020). Formative assessment can be of great value when it provides information to students in a timely fashion that motivates them to stay engaged and succeed (Wafubwa, 2020). Teachers' assessment knowledge, interpretation of evidence, feedback, and adapting instruction have an impact on the quality of formative assessment (Schildkamp et al., 2020). It is also dependent on the cooperation of teachers and students, since desired assessment practices do not always align with students' experiences (Hansen, 2020). In online contexts, learning analytics typically use the digital traces of users, including their clicks, frequency of access, number of days active, and usage of resources to capture their behaviour (Viberg et al., 2018). With meaningful instructional action, analytics-based interventions can improve learning outcomes, if the information produced is useful to the teaching and learning process (Wong & Li, 2020). However, more tasks online is not necessarily more pedagogically valuable and can lead to too much workload and therefore to poorer study results (Motz et al., 2021).

Access, digital competence, communication, institutional support and learning conditions differences also influence student engagement in online higher education (Salas-Pilco et al., 2022). Educational technology can support engagement when it helps learners to be active, to collaborate, to receive feedback, and to be engaged in meaningful interactions, rather than learning to passively receive content (Bedenlier et al., 2020). Good communication, flexible learning environments, easy to access technologies, and instructor support are particularly critical in low-resource countries to ensure participation (Abou-Khalil et al., 2021). When managed properly, synchronous online learning can have a positive impact on cognitive and affective outcomes (Martin et al., 2021).

This study aims to explore how formative assessment practices affect student behaviors and learning in the context of online higher education. It includes assessment completion, assessment type, timely assessment submission, assessment activity in the virtual learning environment, active learning days, weighted assessment performance, and final academic achievement. To describe patterns of formative assessment participation, to compare engagement and learning outcomes across different

groups of students who participate in formative assessments, to explore relationships between submission behaviour, online activity and learning outcomes, and to determine whether formative assessment indicators are predictive of engagement and learning outcomes after controlling for relevant demographic and academic characteristics.

2. Methodology

2.1 Research Design

The study used a quantitative non-experimental research design to explore the correlation between the formative assessment practice, student engagement in behaviour and student learning outcome in online higher education. The means in the analysis were secondary data, since they were collected in other studies. The study was correlational, aimed at revealing statistical relationships between the participation in assessment and submission behaviour, online learning activity and academic performance.

2.2 Data Sources and Sample

In the study, two secondary data sets were used. The first data set comprises of motivational, attendance, study habits, tutoring support, teacher quality, previous academic performance, and examination score variables (Nguyen, 2025). The second data set consists of student demographic information, assessment data and student assignment submission behaviour, virtual learning environment activity, and final academic results (Roy 2025). There was no common student ID variable between the two data sets. Thus, no direct individual level merge was possible. Comparable demographic, engagement, and prior performance attributes were used in the application of statistical matching.

Imputed variables were identified with this procedure as variables that were not directly observed, but rather were introduced. There were 3,948 student-course records in the final analytical data set. These observations were for every participation in a specific online module or course presentation carried out by a student. The data collected comprised demographic information, assessments completed, assessment type, assessment score, when completed, virtual learning environment activity, credits studied, previous attempts to the module, and the final academic outcomes. All the main analyses were conducted using directly observed assessment, behavioural engagement and learning-outcome variables. Only supplementary indicators were saved if there were statistically matched variables. No records were included in the analyses if the principal variables were missing from the records.

2.3 Variables and Measurement

Formative assessment practices were assessed through the number of completed assessments, the

number of computer-marked assessments, the number of tutor-marked assessments, assessment score (mean) and assessment score (weighted) and the on-time submission rate. The on-time submission rate was the percentage of assessments submitted by the due date.

Total clicks in the virtual learning environment and days spent active in the virtual learning environment were used as indicators of behavioural engagement. The total VLE clicks were used as an indicator of the interaction students had with the online learning platform. Active VLE days was the number of days a student was involved in some online learning activities. Weighted assessment score, final course result and a composite learning-outcome index were used to measure the learning outcomes.

Students' final attainment grades were set at withdrawn, fail, pass, and distinction. Pass and distinction were considered successful academic achievement for selected analyses. The composite learning-outcome index was used as an aid to the measure; it included assessment-performance elements. For this reason, Weighted assessment score and final course result were considered as the main academic-outcome indicators. Control variables consisted of the gender, age group, highest educational qualification, disability status, number of credits studied, number of module attempts made, module and presentation period.

2.4 Data Analysis

Descriptive and inferential statistical methods were used to analyse the data. Frequencies and percentages were calculated for categorical variables. Continuous variables were reported as means, standard deviations, medians, minimum and maximum values. Students were grouped by their level of assessment completion into three groups: low, moderate and high. They were also grouped according to their on-time submission rates. One-way analysis of variance (ANOVA) was used to determine differences in behavioural engagement and learning outcomes between these groups.

Pearson correlation analysis was used to see whether there were relationships between assessment count, on-time submission rate, total VLE clicks, active VLE days, weighted assessment score, and the learning-outcome index. To find out if there were relationships between assessment completion and timely submission with behavioural engagement and learning outcomes after controlling for demographic school characteristics, academic school characteristics, and course-related school characteristics, multiple linear regression models were estimated. Standardisation of the predictor variables was carried out prior to regression analysis. Heteroscedasticity was dealt with by using robust HC3 standard errors. The 5% level was used for the determination of statistical significance.

2.5 Ethical Considerations

The data for the study were anonymised secondary data collected from the public. The analysis did

not contain any personally identifiable information. Only for academic research purposes, no use for commercial purposes. Since the study design used observation and statistically matched data, the results were interpreted as associations and not a cause and effect. Particular care was taken in the interpretation of the imputed variables, since these variables were not actually observed for the same children that were represented in the primary education variables.

3. Results

3.1 Participant and Dataset Characteristics

A total of 3948 student-course records were included into the final analytical data set from online higher educational modules. The distribution of the sample was almost equal with 51.2% male and 48.8% female students. The younger students (below 35) represented 70.8% of the observations. About 28.5% were aged 35-55 years and less than 1% over 55 years old. In terms of previous qualifications, four in ten (45.4%) pupils had A-level or equivalent qualifications, and five in ten (39.2%) had qualifications under A-level. Another 13.8% obtained a higher education qualification.

Most students did not undertake the module before. When it comes to final academic status, 48.9% of the students were successful in passing their course and 9.3% were awarded with a distinction. On the other hand, 23.5% failed and 18.4% withdrew. A total of 58.1% of the sample was awarded a successful final result (a pass or distinction). Table 1 indicates that the gender distribution of the sample was almost even with the majority of students being aged below 35 years. It also shows a successful result (pass or distinction) achieved by 58.1% of students.

Table 1. Demographic and Academic Profile of the Sample

Characteristic	Category	Frequency	Percentage
Gender	Female	1,926	48.8%
	Male	2,022	51.2%
Age group	Below 35 years	2,796	70.8%
	35–55 years	1,125	28.5%
	Above 55 years	27	0.7%
Highest education	Below A-level	1,547	39.2%
	A-level or equivalent	1,791	45.4%
	Higher education qualification	545	13.8%

	No formal qualification	35	0.9%
	Postgraduate qualification	30	0.8%
Final result	Withdrawn	725	18.4%
	Fail	927	23.5%
	Pass	1,929	48.9%
	Distinction	367	9.3%

The students were seen completing an average of 7.45 assessments on each of their modules. The mean formative assessment score was 72.59 and the mean weighted assessment score was 69.31. Submission on time was 73.2% on average. There was a significant difference amongst pupils' online behavioural engagement. The average number of clicks in the VLE was 1,640.53 (Standard Deviation 1,952.23).

The students' average online learning days was 72.67. Students' completed assessments differed significantly from each other as can be seen in Figure 1. But a significant percentage of the records were in the higher range of assessment completion. There is a wide range of assessment participation, online engagement, and academic performance in Table 2. Students made 1640.53 clicks on the VLE, and were active for 72.67 days, on average completing 7.45 assessments, and submitting 73.2% of their work on time.

Table 2. Descriptive Statistics for the Principal Study Variables

Variable	N	Mean	SD	Minimum	Median	Maximum
Number of completed assessments	3,948	7.45	3.96	1.00	7.00	14.00
Computer-marked assessments	3,948	2.96	2.97	0.00	2.00	7.00
Tutor-marked assessments	3,948	4.31	1.68	0.00	5.00	6.00
Mean assessment score	3,948	72.59	15.22	0.00	75.57	100.00
Weighted assessment score	3,948	69.31	15.91	0.00	71.40	100.00
On-time submission rate	3,948	0.73	0.29	0.00	0.83	1.00

Total VLE clicks	3,948	1,640.53	1,952.23	0.00	935.00	19,461.00
Active VLE days	3,948	72.67	55.52	0.00	59.00	284.00
Engagement index	3,948	54.36	20.80	0.11	55.42	100.00
Learning-outcome index	3,948	66.97	11.52	18.85	68.35	93.55

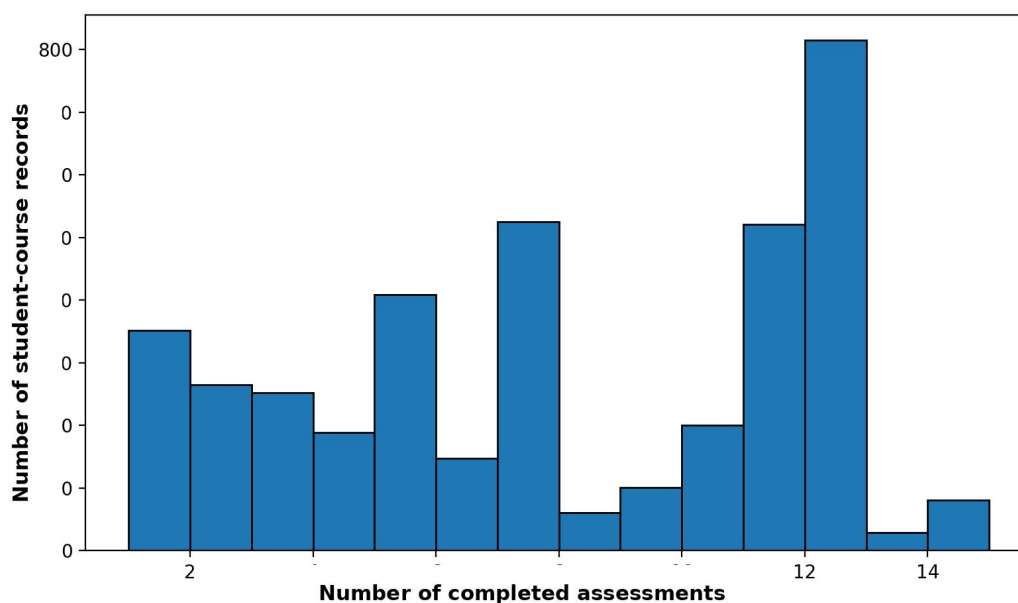


Figure 1. Distribution of Completed Formative Assessments

3.2 Formative Assessment Practices and Behavioural Engagement

A distinction was made between the three groups when it came to behavioural engagement: students who had completed 12 assessments, 11 assessments, and less than 10 assessments. A low-completion group consisted of students who completed one to three assessments, a moderate group consisted of students who completed four to six assessments, and a high completion group consisted of students who completed seven or more assessments. Students in the high assessment-completion group had significantly more online engagement than students in the other groups. They have averaged 2,287.82 VLE clicks and were active for an average of 96.82 days. Students in the low assessment-completion group had an average of just 446.49 VLE clicks and 23.48 active days in comparison. The one way analysis of variance (ANOVA) showed a statistically significant difference in the number of VLE clicks and active days of the three groups that completed the assessments, ($F = 396.12$), ($p < .001$) and ($F = 865.95$), ($p < .001$), respectively.

These results revealed that the more often students completed formative assessments, the higher their level of behavioural participation in the online learning environment. Further, Figure 2 shows how

the three categories of assessment completion fared in terms of VLE engagement. Students who completed seven or more assessments had significantly more online interaction than the others. Students who did seven or more assessments had the highest levels of behavioural engagement and the best learning outcomes as indicated in Table 3. They had a success rate of 83.5% and the students who took one to three had a success rate of 23.0%.

Table 3. Engagement and Learning Outcomes by Assessment-Completion Group

Assessment-completion group	N	Mean VLE clicks	Mean active VLE days	Weighted assessment score	Learning-outcome index	Successful result
Low: 1-3 assessments	869	446.49	23.48	64.02	59.76	23.0%
Moderate: 4-6 assessments	746	1,007.14	54.43	65.15	63.63	46.4%
High: 7 or more assessments	2,333	2,287.82	96.82	72.60	70.72	83.5%

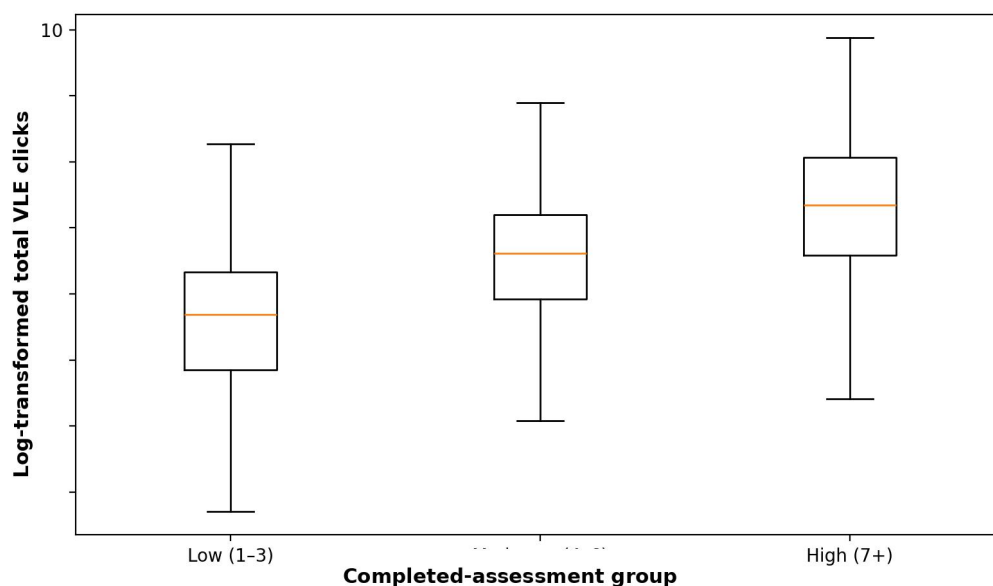


Figure 2. Online Engagement by Completed-Assessment Group

There was a positive association between on-time submission and online engagement as well. The students with less than 50% on-time submissions had an average of 872.69 VLE clicks and 53.54 "active learning days. Students who submitted their work on time (80% - 99%) had 2,560.90 clicks

and 94.19 days of active learning. The S1 students who had a perfect submission rate also had a relatively high engagement score, but with a slightly lower average VLE activity than the 80%–99% group. This indicates that the highest levels of platform compliance were not necessarily associated with the highest levels of platform activity. The overall trend shown in Figure 3 is that the number of VLE days increased with a higher proportion of assessments submitted on time. Table 4 indicates that most of the VLE activity scores, learning days scores and academic performance scores were higher for the higher on-time submission rates. The VLE clicks and active days were the highest for students in the 80%–99% submission range.

Table 4. Engagement and Outcomes by On-Time Submission Category

On-time submission category	N	Mean submission rate	Mean VLE clicks	Mean active days	Weighted score	Learning-outcome index
Low: below 50%	805	0.28	872.69	53.54	65.03	63.38
Moderate: 50%–79%	963	0.58	1,237.83	67.41	67.77	65.91
High: 80%–99%	528	0.86	2,560.90	94.19	70.33	69.08
Perfect: 100%	1,652	1.00	1,955.27	78.18	71.96	68.66

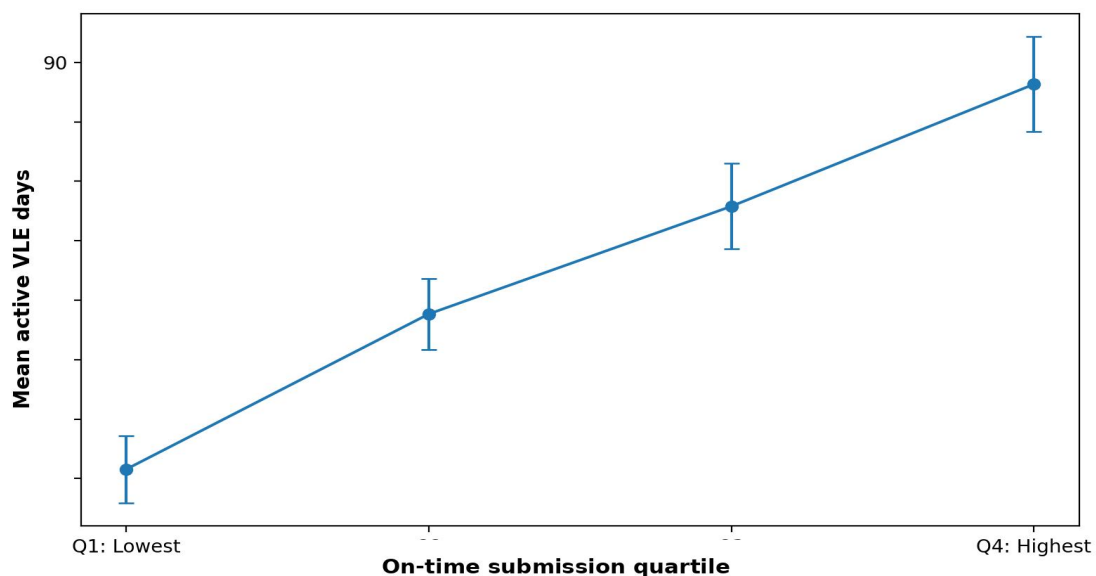


Figure 3. Active Learning Days Across On-Time Submission Groups

3.3 Formative Assessment Practices and Learning Outcomes

The more successful students in terms of learning outcomes were those who entered more assessments. The mean weighted assessment score was higher for the high-completion group (72.60) than for the low-completion group (64.02). Likewise, learning-outcome index rose from 59.76 to 70.72 on average. A difference in weighted assessment scores between the assessment-completion groups was statistically significant, ($F = 131.63$), ($p < .001$). Significant differences were also found for the learning-outcome index, ($F = 389.67$), ($p < .001$).

There was also a significant increase in success in the actual final products among the groups. Just 23.0% of all students who finished 1-3 assessments received a pass or distinction. This percentage rose to 46.4% for students taking 4-6 assessments and to 83.5% for students taking 7+ assessments. The learning-outcome index scores of students also clearly showed the end-classification of students (Figure 4). The students who have been awarded distinction had the highest index value followed by the pass students. The lower scores were found in students who failed or withdrew.

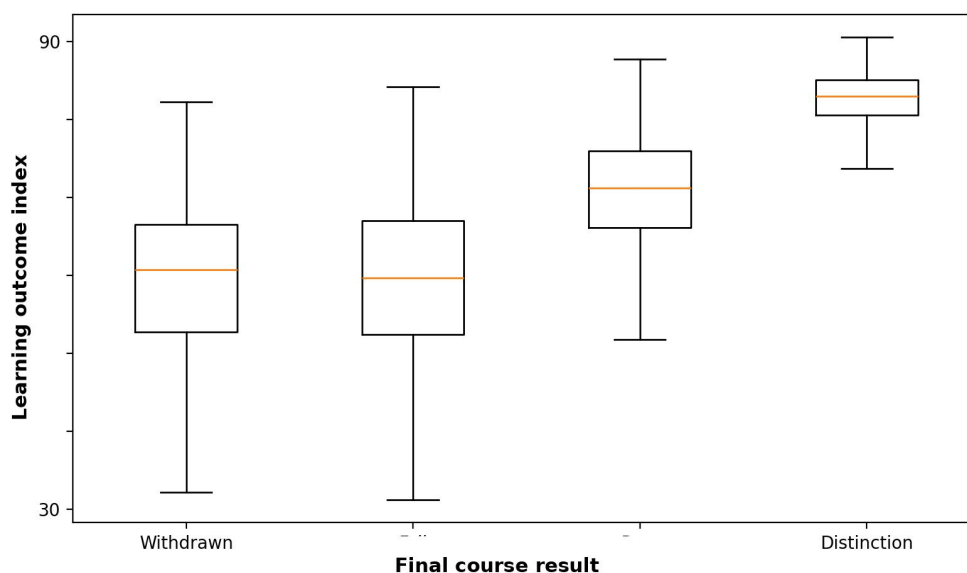


Figure 4. Learning-Outcome Index by Final Course Result

Examination of formative assessment participation and behavioural engagement and learning outcomes using correlation analysis also confirmed positive relationships between them. There was a moderate correlation between assessment count and total VLE clicks ($r = .50$), active VLE days ($r = .57$), and the learning outcome index ($r = .42$). The total number of clicks on VLE's, active days on VLE's, weighted assessment scores and learning-outcome index were positively related, although more weakly, with on-time submission, ($r = .27, .22, .19$ and $.21$ respectively). There was the strongest relationship between total VLE click and active VLE days ($r = .80$). This suggests that there was a correlation between the frequency of students' interactions with the online learning

system and the number of days they remained active. A positive association between timely assessment submission and weighted assessment performance is shown in Figure 5.

While there was a lot of variation in on-time submission at each submission level, the fitted trend line suggested that students who submitted higher percentages on time tended to score higher on the assessment. The positive relationships for the formative assessment participation, behavioural engagement, and learning outcomes are presented in Table 5. Total VLE clicks correlated moderately with engagement measures and the learning-outcome index, and moderately with active VLE days, with the highest level of correlation being found between total VLE clicks and active VLE days.

Table 5. Correlations Among Formative Assessment, Engagement, and Outcome Variables

Variable	1	2	3	4	5	6
1. Assessment count	1.00					
2. On-time submission rate	-.04	1.00				
3. Total VLE clicks	.50	.27	1.00			
4. Active VLE days	.57	.22	.80	1.00		
5. Weighted assessment score	.27	.19	.30	.32	1.00	
6. Learning-outcome index	.42	.21	.39	.44	.97	1.00

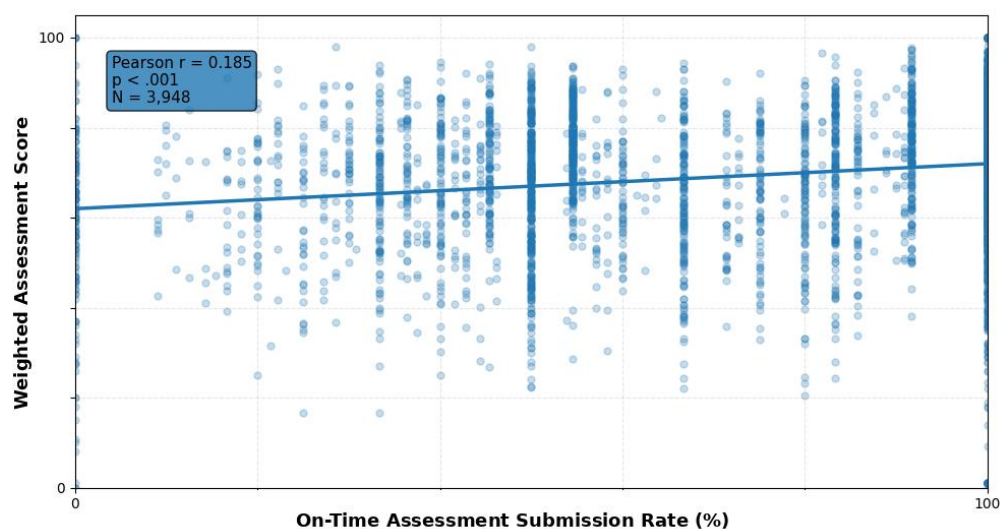


Figure 5. On-Time Submission and Weighted Assessment Performance

3.4 Multivariable Analysis

Multiple regression analysis was undertaken to assess whether there were any residual relationships between the assessed variables (assessment completion and timely submission) and the dependent variables (behavioural engagement and learning outcomes) when all of the above mentioned variables (studied credits, previous module attempts, gender, age, educational attainment, disability status, module, and presentation period) were controlled. In both cases, the variables used in the formative assessment were standardised prior to the regression models.

Thus, each coefficient is the mean change in the dependent variable per standard deviation unit change in the predictor. The number of assessments completed and on time were statistically significant predictors for both of the measures of behaviour engagement. We found a significant association between a 1-standard-deviation increase in assessment count and a 0.72-unit increase in log-transformed VLE clicks ($r = 0.72$), and a 32.74-day increase in active VLE days. For each increase of 1 standard deviation in on time submission, there was a corresponding increase of 0.18 (log transformed) on VLE clicks and a corresponding increase of approximately 9.98 (log transformed) active VLE days.

The model accounted for 55.0% of the variance of log transformed VLE clicks and 44.8% of the variance in active VLE days. Academic performance was also significantly and positively related to both formative assessment indicators. Increased by one SD of the assessment count was correlated with an increase of 3.56 points in the weighted assessment score and a 4.66-point increase in the learning-outcome index. For every 1 standard deviation increase in the on-time submission rate, there was a corresponding increase of 3.14 points in the outcome and 2.74 points in the outcome. Demographic, academic, course-related and assessment related factors were kept as controls and assessment count and on-time submission continued to be significant predictors of behavioural engagement and academic performance as seen in Table 6. The number of assessments was highly correlated with VLE activity and active learning days.

Table 6. Adjusted Regression Models Predicting Engagement and Learning Outcomes

Dependent variable	Predictor	Standardised-unit coefficient	Robust SE	p-value	Model (R^2)
Log total VLE clicks	Assessment count	0.721	0.016	<.001	.550
	On-time submission rate	0.176	0.018	<.001	

Active VLE days	Assessment count	32.735	0.619	<.001	.448
	On-time submission rate	9.980	0.647	<.001	
Weighted assessment score	Assessment count	3.557	0.281	<.001	.150
	On-time submission rate	3.139	0.323	<.001	
Learning-outcome index	Assessment count	4.663	0.183	<.001	.265
	On-time submission rate	2.740	0.213	<.001	

3.5 Summary of the Main Findings

Four main findings were derived from the results. First, students who finished more formative assessments had much higher levels of online behavioural engagement. Second, submission of the assessment was positively linked with VLE activity, active learning days and academic performance at a timely manner. Third, the better learning outcomes and higher pass rates of students who completed seven or more assessments compared to those who completed fewer assessments were statistically significant. Fourth, the associations still were statistically significant when controlling for relevant demographic and academic characteristics.

The findings collectively suggest that behavioral engagement and learning outcomes in online higher education are positively associated with frequent engagement in formative assessment activities and timely submission. These relationships, however, are based on observational data, so should not be read as direct causation of the observed engagement or academic performance differences due to formative assessment practices.

4. Discussion

The results showed that students' participation in formative assessment had a positive association with their behavioural engagement and learning outcomes in the online higher learning setting. Those that had more assessment counts tended to click more in the virtual learning environment, be more active for more learning days, score more on the weighted assessment, and pass or earn a distinction more often. The pattern aligns with the belief that online (OHE) platform interactions,

participation frequency, and assessment completion can offer valuable insights into student engagement in online higher education (Bergdahl et al., 2024). The findings that students' engagement in online behaviors positively correlate with their completion of assessments align with research that suggests when learning is scaffolded around meaningful engagement and sustained engagement, then online learning is able to support the participation of students (Bond et al., 2020). In addition, the greater engagement seen with the students who finished seven or more assessments is an indication of the potential of online self-assessment to foster regular practice, monitoring, and participation (Büchele et al., 2025). The variations in the number of days spent on active learning and interactions with the VLE can also be interpreted considering the structure of online learning. The flexibility of a combination of synchronous and asynchronous learning can impact participation patterns and students' overall learning experience (Fabríz et al., 2021). Based on the findings of the present research, it seems that formative assessment may be a recurring contact point to make students revisit the learning platform and access learning materials.

When considering whether there was a correlation between timely submission and greater engagement, it suggests that submission behaviour may be more than just about administrative compliance. It can be related to students planning, persistence and responding to the course expectations. Digital formative assessment can give teachers instant feedback on pupils' learning and learning challenges, which can guide instructional interventions and pupil monitoring (Grimalt-Álvaro & Usart, 2024). The design, access, feedback and alignment of tasks to learning outcomes are all factors that contribute to the effectiveness of online assessment, however (Heil & Ifenthaler, 2023). The results also confirm the value of using learning analytics to gain insights into student behaviour that would tell something meaningful. Participation, achievement and learning progress can be made visible through dashboards and analytics systems, both for students and instructors (Kaliisa et al., 2024). However, the impact of such systems is contingent on the integration of assessment data, feedback, and student support with pedagogy (Kaya-Capocci et al., 2022).

The results of our analysis are similar to the results from previous studies showing that engagement and formative assessment performance can predict overall course achievement (Lu & Cutumisu, 2022). The results further indicate that the regular involvement in assessment can lead to greater students' active learning decisions and feedback response (Zenouzagh Mohammadi et al., 2025). The research into digital assessment, learning analytics and student-centred evaluation, which has grown over the last few years, has shown that online formative assessment is becoming increasingly significant for higher education (Sudakova et al., 2022). While the benefits of using analytics-based assessment systems are clear, the institutional challenges to their implementation, particularly at the

pedagogical, data governance, technology, and staff capacity levels, may restrict their practical application (Tsai et al., 2020). With implementation, these systems can help identify disengaged and/or academically at risk students at an early stage (Ifenthaler & Yau, 2020).

There was a high correlation between the VLE clicks and active learning days, indicating that engagement was not just limited to visits to the platform. In contrast, those who were engaged in more frequent interactions were also more likely to maintain their engagement for a longer period of time. This helps in supporting the use of the dashboard-based indicators for self-regulated learning behaviour (Matcha et al., 2019). Feedback mechanisms that link digital behaviour with planning, monitoring and reflection could also further enhance learning regulation (Sedrakyan et al., 2020). The positive correlation between the participation in formative assessment and achievement also aligns with the findings that, when students are given useful information about their progress, formative assessment is likely to positively influence their motivation, persistence and academic performance (Wafubwa, 2020). However, its effectiveness is linked to some extent with teachers' assessment literacy, feedback practices and how they interpret evidence of learning (Schildkamp et al., 2020). However, student experience needs to be taken into account as assessment practices can be intended versus experienced (Hansen, 2020). It also illustrates the benefits of analysing learning analytics indicators, like clicks and active days, as well as the submission patterns for studying behaviour engagement (Viberg et al., 2018).

With the translation of such data into effective academic supports, analytics-based interventions could enhance learning outcomes (Wong & Li, 2020). It is also important to note that the results cannot be interpreted as evidence for more assessments, but also taking quality into account since too many units offered online can have a negative effect on achievement and generate unnecessary workload (Motz et al., 2021). Digital access, institutional support, communication, and learning conditions also play a role in engagement in online higher education (Salas-Pilco et al., 2022). Educational technology will be most effective when it encourages students to be active learners, work in groups, and give and receive feedback (Bedenlier et al., 2020). Flexibility, accessibility, and providing clear communication by the teacher are significant, especially in low resource areas (Abou-Khalil et al., 2021). The same holds true for the advantages of synchronous online education: the quality of interaction and instructional design (Martin et al., 2021).

The results indicated that, overall, participation in formative assessment and prompt submission are significant correlates of behavioural engagement and academic achievement. However, the study does not allow causal interpretation due to its observational study design and due to the statistical matching methodology used. The results should therefore be interpreted as evidence of association,

not evidence that formative assessment is directly responsible for increased engagement and/or learning outcomes.

5. Conclusion

This study explored the impact of formative assessment practices on behavioural engagement and learning outcomes of online students in higher education. The results revealed a positive relationship between online engagement and the increased number of active learning days, and a positive relationship between online engagement and virtual learning environment activities, when formative assessment was increased. Additionally, timely submission was positively correlated with engagement, indicating that students who completed assessments on time were more likely to be engaged in the online learning experience. The findings also showed that students who did more formative assessments and who were on time to submit work had higher weighted assessment scores and higher final academic achievement. These connections were still present even when other significant demographic, academic, and course-related variables were taken into account. Participation and submission behaviour in formative assessment seem to be appropriate indicators of patterns of student engagement and academic progress in online learning settings. The results have implications for postsecondary institutions. A good formative assessment can allow for frequent participation, feedback, self-monitoring and identification of students who may be at risk of disengagement or poor performance. However, the quality of assessment, its relevance, timing and load should be prioritised in place of merely more tasks. The study was based on secondary observational data and used statistical matching to combine datasets without a common student identifier. Thus the results need to be seen as associations and not as cause and effect. Further investigations in the field should investigate the influence of specific formative assessment practices on motivational variables and learning outcomes using longitudinal or experimental designs, and directly measured motivational variables.

References

1. Abou-Khalil, V., Helou, S., Khalifé, E., Chen, M. A., Majumdar, R., & Ogata, H. (2021). Emergency online learning in low-resource settings: Effective student engagement strategies. *Education Sciences*, 11(1), 24.
2. Bedenlier, S., Bond, M., Buntins, K., Zawacki-Richter, O., & Kerres, M. (2020). Facilitating student engagement through educational technology in higher education: A systematic review in the field of arts and humanities. *Australasian Journal of Educational Technology*, 36(4), 126-150.

3. Bergdahl, N., Bond, M., Sjöberg, J., Dougherty, M., & Oxley, E. (2024). Unpacking student engagement in higher education learning analytics: a systematic review. *International Journal of Educational Technology in Higher Education*, 21(1), 63.
4. Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International journal of educational technology in higher education*, 17(1), 1-30.
5. Büchele, S., Feiste, L., Müller, R., & Schürmann, M. (2025). Online self-assessments and student engagement: a causal analysis in university mathematics. *Education and Information Technologies*, 30(18), 26235-26260.
6. Fabriz, S., Mendzheritskaya, J., & Stehle, S. (2021). Impact of synchronous and asynchronous settings of online teaching and learning in higher education on students' learning experience during COVID-19. *Frontiers in psychology*, 12, 733554.
7. Grimalt-Álvaro, C., & Usart, M. (2024). Sentiment analysis for formative assessment in higher education: a systematic literature review. *Journal of computing in higher education*, 36(3), 647-682.
8. Hansen, G. (2020). Formative assessment as a collaborative act. Teachersintention and studentsexperience: Two sides of the same coin, or?. *Studies in Educational Evaluation*, 66, 100904.
9. Heil, J., & Ifenthaler, D. (2023). Online Assessment in Higher Education: A Systematic Review. *Online Learning*, 27(1), 187-218.
10. Ifenthaler, D., & Yau, J. Y. K. (2020). Utilising learning analytics to support study success in higher education: a systematic review. *Educational technology research and development*, 68(4), 1961-1990.
11. Kaliisa, R., Misiejuk, K., López-Pernas, S., Khalil, M., & Saqr, M. (2024, March). Have learning analytics dashboards lived up to the hype? A systematic review of impact on students' achievement, motivation, participation and attitude. In *Proceedings of the 14th learning analytics and knowledge conference* (pp. 295-304).
12. Kaya-Capocci, S., O'Leary, M., & Costello, E. (2022). Towards a framework to support the implementation of digital formative assessment in higher education. *Education*

13. Lu, C., & Cutumisu, M. (2022). Online engagement and performance on formative assessments mediate the relationship between attendance and course performance. *International journal of educational technology in higher education*, 19(1), 2.
14. Martin, F., Sun, T., Turk, M., & Ritzhaupt, A. D. (2021). A meta-analysis on the effects of synchronous online learning on cognitive and affective educational outcomes. *International Review of Research in Open and Distributed Learning*, 22(3), 205-242.
15. Matcha, W., Uzir, N. A. A., Gašević, D., & Pardo, A. (2019). A systematic review of empirical studies on learning analytics dashboards: A self-regulated learning perspective. *IEEE transactions on learning technologies*, 13(2), 226-245.
16. Motz, B. A., Quick, J. D., Wernert, J. A., & Miles, T. A. (2021). A pandemic of busywork: Increased online coursework following the transition to remote instruction is associated with reduced academic achievement. *Online Learning*, 25(1), 70-85.
17. Nguyen, L. (2025). Student performance factors [Data set]. Kaggle. <https://www.kaggle.com/datasets/lainguyn123/student-performance-factors>
18. Roy, A. A. (2025). OULAD dataset trimmed [Data set]. Kaggle. <https://www.kaggle.com/datasets/ankulabhishekroy/oulad-dataset-trimmed>
19. Salas-Pilco, S. Z., Yang, Y., & Zhang, Z. (2022). Student engagement in online learning in Latin American higher education during the COVID-19 pandemic: A systematic review. *British journal of educational technology*, 53(3), 593-619.
20. Schildkamp, K., van der Kleij, F. M., Heitink, M. C., Kippers, W. B., & Veldkamp, B. P. (2020). Formative assessment: A systematic review of critical teacher prerequisites for classroom practice. *International journal of educational research*, 103, 101602.
21. Sedrakyan, G., Malmberg, J., Verbert, K., Järvelä, S., & Kirschner, P. A. (2020). Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation. *Computers in Human Behavior*, 107, 105512.
22. Sudakova, N. E., Savina, T. N., Masalimova, A. R., Mikhaylovsky, M. N., Karandeeva,

-
- L. G., & Zhdanov, S. P. (2022). Online formative assessment in higher education: Bibliometric analysis. *Education Sciences*, 12(3), 209.
23. Tsai, Y. S., Rates, D., Moreno-Marcos, P. M., Muñoz-Merino, P. J., Jivet, I., Scheffel, M., ... & Gašević, D. (2020). Learning analytics in European higher education—Trends and barriers. *Computers & Education*, 155, 103933.
24. Viberg, O., Hatakka, M., Bälter, O., & Mavroudi, A. (2018). The current landscape of learning analytics in higher education. *Computers in human behavior*, 89, 98-110.
25. Wafubwa, R. (2020). Role of formative assessment in improving students' motivation: A systematic review of literature. *The International Journal of Assessment and Evaluation*, 28(1), 17.
26. Wong, B. T. M., & Li, K. C. (2020). A review of learning analytics intervention in higher education (2011–2018). *Journal of Computers in Education*, 7(1), 7-28.
27. Zenouzagh Mohammadi, Z., Admiraal, W., & Saab, N. (2025). Empowering students' agentive engagement through formative assessment in online learning environment.