***To Investigate Students' Learning Experience by Re-designing a University Science
Laboratory Subject Using Alternative Assessment and Digital Technology***

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Abstract

The COVID-19 pandemic has caused significant changes in education, including the shift to online or hybrid formats for science laboratory sessions. This study utilized Learning Analytics (LA) from 2021/2 to 2023/4 academic year to examine how science students' learning patterns were affected during and after COVID isolation. The findings indicated that a selected laboratory subject, which was re-designed using group project as alternative assessments, can beneficial for student learning and engagement. The study found that students' performance was higher in the F2F mode of delivery and alternative assessment methods enhanced students' learning experience and understanding. Additionally, preliminary findings suggest that around 71% of students found the GenAI-empowered videos were helpful in understanding the subject matter and enhanced students' learning experience. Further research is needed to confirm these findings and explore their implications for science education in a post-pandemic context.

Keywords: Alternative Assessment, Learning Analytics, Digital Technology

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Introduction

COVID pandemic posts significant impact on education including assessment practices. such as significant challenges for proctoring online at-home closed book assessments as it is difficult to ensure that students are complying with closed-book instructions. In order to avoid academic misconduct, alternative assessments such as closed-book assessments with online proctoring, open-book examination, project, presentation, essay can be employed to minimize cheating. In addition, those alternative assessments assess students' higher order thinking skills (Dikli, 2003; Gipps & Stobart, 2003; Ashford-Rowe et al., 2014). Alternative assessments, instead of fact memorization, can have a positive influence on learning and instruction, measure higher order skills and motivate is still being substantiated (Wiggins, 2011; Taras, 2002). There are many alternative assessments that can be used in place of traditional exams to reduce the likelihood of cheating, such as projects, presentations, essays and others. By using a variety of different assessment methods, educators can ensure that students are being assessed fairly and accurately, while also promoting deeper learning and engagement.

Rubric articulates the expectations for an assignment by listing the criteria or what counts, and describing levels of quality from excellent to poor (Andrade 2000; Stiggins et al. 2012). Rubrics are effective for both learning and evaluation as they can provide a clear and consistent framework to evaluate students' work. A rubric based on Biggs' Structure of Observed Learning Outcomes (SOLO) taxonomy can assist students in providing assessment criteria, expectations and judgement (Rembach & Dison, 2016). Rubrics have been adopted for assessing students' work in the field of education since the 1960s (Diederich, French, & Carlton, 1961). Rubrics were used in the United States in the early 1970s (Rezaei & Lovorn, 2010). Nowadays, they are widely adopted in higher education. Rubrics can be defined as a collection of criteria for assessing students' work; these criteria consist of descriptions of the performance and standards that students are expected to achieve (Brookhart, 2018). Rubrics enhance transparency in the evaluation of students' work (Williamson, 2017), and as a scoring system is used to calculate final scores from various criteria. When rubrics are established, it makes it easier for stakeholders to know the standard and learning outcomes (Kite & Phongsavan, 2017). Students can also foresee the good quality required in their work, helping them determine how to achieve the required standard (Dickinson & Adams, 2017). Rubrics help them to improve the quality of their work via self-assessment. Using a rubric allows teachers to grade students' work objectively, consistently, and fairly. By providing clear criteria and descriptors, teachers can avoid subjective judgments and ensure that all students are evaluated using the same standards. Rubrics can also communicate expectations and learning outcomes between educators and learners. Exemplars of authentic student work illustrate different levels of performance and enable teachers to share tacit knowledge which may remain opaque to students (Sadler, 2010). A powerful rationale for their use is that students need to gain experience in making judgements about work of different quality, create verbalized accounts of how various works could have been improved, and engage in evaluative conversations with teachers and other students (Sadler, 2010). Criteria can seem highly abstract to students, whereas exemplars represent the concrete embodiment of standards and accordingly can support students in developing their assessment literacy (Price et al., 2012). Azevedo and Amélia (2017) found that project-based learning had a positive effect on students' engagement in chemistry course, and that the effect was mediated by students' sense of autonomy and competence. Chen and Zhou (2019) found that project-based learning had a positive effect on both motivation and engagement, and that the effect was larger for project-based learning than for traditional instruction.

Generative AI is digital technology that can quickly create new and realistic visual, textual and animated content for educators. Digital technology advancement can help create realistic simulations that can help engage learners to actively learn outside of the classroom, such as in virtual tutorials. Generative AI offers teachers a practical and effective way to develop massive amounts of unique materials quickly including quick response to students' frequency asked questions (FAQs) in virtual tutoring, review of concepts and explanation as well as revision exercise/quizzes. In addition, AI can generate scripts for video lectures or podcasts, streamlining multimedia content creation for teaching and learning materials and AI-generated tutors can allow students to interact with a virtual tutor and receive real-time feedback outside of the classroom. Generative AI technology can assist educators to modify their teaching materials, such as adding suitable scripts or subtitle in video recordings and virtual tutorials to help our students including SEN students who cannot hear or cannot concentrate during F2F classes.

Based on the benefits of using alternative assessment with detailed rubrics, together with the current trends of using GenAI-empowered videos was found to enhance students; learning experience in science laboratory teaching. This study aimed to explore the use of project-based alternative assessments with detailed grading rubrics during and after COVID isolation. We also investigated students' perception of rubrics and alternative assessments as well as the impact of GenAI empowered videos to assist students' flipped laboratory learning. Findings of this study will provide insights into the pandemic's impact on students' learning performance in science education and the role of alternative assessments and rubrics as well as digital technology in supporting student learning in a laboratory subject.

Methodology

This study was conducted with undergraduate (UG) students of two cohort who took the subject, ABCT3625 Chromatographic Analysis Laboratory from the academic year 2021/22 to 2022/23. In response to the challenges posed by the COVID-19 pandemic, we substituted traditional tests with a group project with detailed rubrics as an alternate assessment method since 2021/2 academic year. We assessed student performance based on their participation in laboratory classes, their laboratory reports, and their group project. This practice was maintained even after the isolation period, and we examined the effects of this approach on student learning during and post-isolation. During the first semester of 2021/22, we can only deliver our laboratory classes online via a meeting platform. However, by the first semester of 2022/23 and 2023/4, we were able to resume face-to-face (F2F) mode of class delivery.

We utilized 6-point Likert scale online questionnaire survey and focused group interview were conducted to collect students' learning experiences and analyzed their digital activity in the learning management system (Blackboard Learn) and academic performance to gain insights into how the pandemic influenced their learning patterns and performance.

Student Data Collection

E-survey was distributed via email and students' views and experiences about rubrics and the alternative assessment was collected after they submitted their work (post-survey). There are four items gauging students' views about the use of rubrics, twelve items on the helpfulness of rubrics for their learning, and ten items on the ways in which the alternative assessment could help them learn. A few others seek to know the student's background, level of confidence in understanding all the marking criteria in the rubric, their expected grade for the

assessment, their previous experience in doing similar kind of assessments, and if they had referred to the rubric/teachers' feedforward when preparing for the assessment (only appeared in the post-survey). Students were also invited to join a 1-hour focus group discussion after they have completed the course. To show our appreciation, each participating student was rewarded with a set of cash coupons amount to HKD100. A semi structure protocol was used to follow up on participating students' perceptions and experiences about assessment and use of rubric in general, and the alternative assessment and the feedforward/feedback they were given in particular. A total of 65 UG Year 2 students enrolled in the subject in 2021/22 and 2022/23 semester participated in this study. Table 1 shows the student data collected for the student cohorts of 2021/22 to 2022/23.

Table 1. Number of Students Enrolled in the Subjects and Participated in the Study

	2021/22 Cohort	2022/23 Cohort
No. of students enrolled	33	32
No. of students participated in the survey	17	24
Response rate	51.5%	75.0%
No. of students participated in focus group	4	N/A

GenAI empowered videos were integrated in the same laboratory subject in 2023/24 cohort. An online survey and focus group was conducted to collect students' views on the impact of GenAI empowered videos in their flipped laboratory learning. 32 out of 38 students (a response rate of 84.2%) answered the online survey and 2 students participated in the focus group interview.

Results and Findings

Referring to the learning analytics data extracted from our learning management system (LMS) Blackboard Learn, the average student access frequency in all course tools is summarized in Figure 1. According to the learning analytics data, the average student access frequency in all course tools is similar between 2021/2 (during COVID isolation) and 2022/3 (after COVID isolation) academic year, except week 9-12. The student access frequency reached a peak in week 10 for 2022/3 cohort while week 11 for 2021/2 cohort. It seems that students in 2022/3 cohort prepared their project presentation earlier than 2021/2 cohort. This observation coherent with their academic performance, where students with average GPA score of 3.42 and 3.15 for 2022/3 and 2021/2 cohort, respectively. In addition, the percentage of A grade students in 2022/3 cohort (43.7%) was much higher than 2021/2 cohort (21.2%). During COVID isolation, we received students' feedback about the pandemic isolation affected their learning mode. From Learning Analytics, it seems that Face-to-face (F2F) mode of class delivery can enhance students' active learning with reference to purely online during isolation.
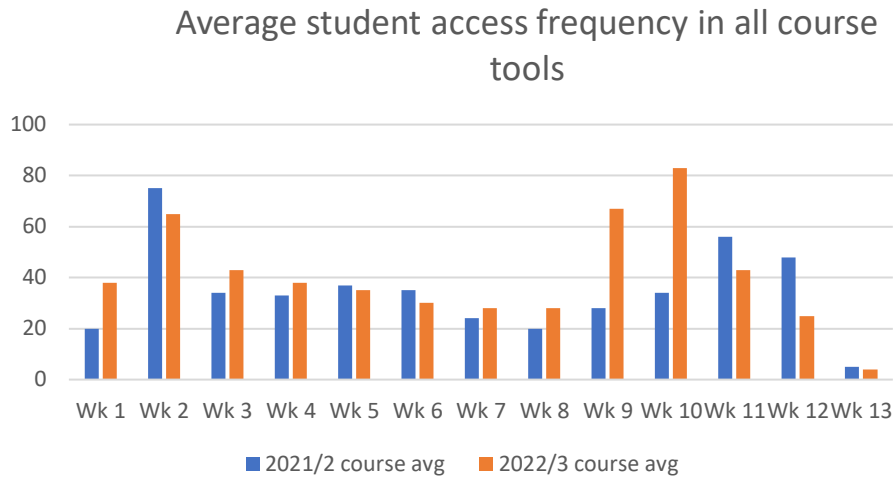
Average student access frequency in all course tools

Figure 1. Average ABCT3625 Student Access Frequency in All Course Tools in Blackboard Learn in 2021/2 and 2022/3 Cohort

Students' Perception on Rubrics

Regarding students' perception of rubrics, both cohorts of students were very positive towards rubrics, as over 90% of students agreed or strongly agreed with the four statements about rubrics, with all the average score above 4 out of a 6-point Likert scale. This indicated that the rubric was perceived positively by students in terms of its use as a marking scheme, transparency, objective grading, and provision of assessment criteria and performance descriptors.

Table 2. Students' Perception of Rubrics for Their Alternative Assessment

How much do you agree with the following statements about the rubric?	2021/2022 (N=17)		2022/2023 (N=24)	
Response options: 6=Strongly agree, 5=Agree, 4=Somewhat agree, 3=Somewhat disagree, 2=Disagree, 1=Strongly disagree	% of students choosing 4 to 6	Average score ± SD	% of students choosing 4 to 6	Average score ± SD
It is a marking scheme for teacher use	94.1	4.8±0.7	91.7	4.5±0.9
It makes assessment more transparent	100.0	5.1±0.4	95.8	4.7±0.8
It allows objective, consistent and fair grading	100.0	5.0±0.5	95.8	4.8±0.7
It shows me the assessment criteria and performance descriptors	100.0	4.9±0.6	95.8	4.7±0.8

The questionnaire survey looked into the way how the rubrics of the group presentation had helped students learn. From the 12 items surveyed, average scores of all the items were above 4, suggesting that students generally thought that rubrics helped them adequately in all these areas. In particular, "*assessment the quality of my own work/my peers' work*" got the highest average score for both cohorts of students. This suggested that students agreed that the rubrics helped them to assess the quality of their own work/their peers' work.

Generally speaking, students in 2021/22 rated higher than those in 2022/23. In other words, students in the online mode of delivery tended to appreciate the value of rubrics in helping them in planning, preparing, and reflecting on the assessment. Particularly, "*become less stressed in preparing the assignment*" showed a big drop from 2021/2022 to 2022/23. In

2021/22, 87.5% students agreed that the rubric helped them become less stressed in preparing the assignment whilst in 2022/23 only 65.2% of students in 2022/23 did so. Arguably, students in the online mode of delivery were passive, seldom spoke up during the online sessions, and less opportunities to talk to teacher and students face-to-face. Rubrics played an important role in providing hints to prepare what to include and how to complete the assessment. Students in the face-to-face mode of delivery were with more opportunities to ask teachers and peers to clarify their requirements and expectations on the assignment. Rubric's role became less important.

Table 3. Students' Perception of Rubrics for Their Alternative Assessment

To what extent do you think the rubric used in this group presentation task has helped you learn in the following ways? (Please select "no experience" if you have not used the rubric in the specific way) Response options: 6=very much, 5=much, 4= adequate, 3=little, 2=very little, 1=Not at all, No experience (=X)	2021/2022 Cohort (N=17)		2022/2023 (N=24)	
	% of students choosing 4 to 6	Average score ± SD	Average % of students choosing 4 to 6	Average score ± SD
Understand the expectations and components of an assignment	87.5	4.4±0.8	91.3	4.3±0.8
Plan how much time to spend on my assignment	93.3	4.5±0.6	78.3	4.2±0.9
Prepare for what to include and how to complete my assignment	93.3	4.5±0.6	82.6	4.3±1.0
Obtain the teacher's feedback on how to improve the quality of my assignment	75.0	4.1±0.8	77.3	4.1±1.0
Assess the quality of my own work/my peers' work	100.0	4.6±0.5	91.3	4.5±0.9
Discuss with peers what we are expected to achieve in the assignment	93.3	4.5±0.7	82.6	4.2±0.9
Set my learning goals	81.3	4.1±0.7	78.3	4.0±1.0
Create a work of a higher quality	87.5	4.1±1.0	87.0	4.2±0.9
Become less stressed in preparing the assignment	87.5	4.2±1.1	65.2	4.0±1.1
Become more confident in preparing the assignment	93.3	4.5±0.6	77.3	4.0±1.0
Understand my strengths and weaknesses in the learning	87.5	4.2±0.8	87.0	4.3±0.8
Monitor, reflect and improve my learning	93.8	4.3±0.6	82.6	4.3±0.9

Students' Perception on the Alternative Assessment

The survey also probed into the way how the alternative assessment, i.e., the group presentation, had helped students learn. Our findings suggested that students in both cohorts were very positive towards the alternative assessment. Among the 10 items surveyed, 7 items were with over 90% of students agreed or strongly agreed the specific item. In particular, 95% or more students agreed that alternative assessment:
- Deepened their learning of the knowledge and theories taught in the subject.
- Provided me opportunities to apply their academic learning to real world problems/ situations.
- Helped to develop their skills in evaluating and making judgement about different qualities of work.

Generally speaking, students in 2021/22 cohort rated higher than those in 2022/23. It seemed that students in 2021/22 knew how to perform well and put more time and effort to do well in the alternative assessment than those in 2022/23.

Table 4. Students' Perception of the Impact of Alternative Assessment

How far do you agree the group presentation helped you learn in the following ways?	2021/2022 (N=17)		2022/2023 (N=24)	
Response options: 6=strongly agree, 5=Agree, 4=somewhat agree, 3= somewhat disagree, 2=Disagree, 1=strongly disagree, Not applicable/ No idea (=X)	% of students choosing 4 to 6	Average score ± SD	% of students choosing 4 to 6	Average score ± SD
It deepened my learning of the knowledge and theories taught in the subject	100	4.8±0.5	100.0	4.4±0.6
It provided me opportunities to apply my academic learning to real world problems/ situations	100	4.6±0.7	95.8	4.5±0.7
It helped to develop my own skills in evaluating and making judgement about different qualities of work	100	4.7±0.7	95.8	4.4±0.7
It enhanced my creativity	94.1	4.6±0.7	91.3	4.4±0.8
It enhanced my problem-solving skills	94.1	4.5±0.7	91.7	4.5±0.8
It enhanced my critical analysis	94.1	4.6±0.6	91.7	4.5±0.8
It enhanced my presentation skills	94.1	4.7±0.8	91.7	4.5±0.8
It took me more time and effort to do well in this kind of assessment than in traditional exams/ tests	94.1	4.6±0.7	87.5	4.4±1.0
I know how to perform well in this kind of assessment	93.8	4.7±0.7	87.0	4.3±0.8
I prefer doing this kind of assessment than taking traditional exams/ tests	88.2	4.9±1.4	87.5	4.3±1.1

Students' Views on the GenAI-Empowered Videos

Results of the student survey (Table 5) revealed that all the survey items were with over 60% of students chose "agreed" or "strongly agree", suggesting that students were positive towards the use of GenAI-empowered videos in the virtual tutorials. In particular, 74% of students agreed or strongly agreed that the GenAI-empowered videos (i.e., the virtual tutorial materials) were helpful in aiding their understanding of the subject matter and that the GenAI-empowered videos improved their overall learning experience. Refer to Table 5, more than two thirds of students agreed or strongly agreed that GenAI-empowered videos motivated them to learn new things.

Table 5. Students' Views on the GenAI-Empowered Videos

	2023/2024 (N=32)	
	% of students chose agree and strongly agree	Average score ± SD
1.The GenAI videos were helpful in aiding your understanding of the subject matter.	74.2%	3.6±1.3
2.The materials improve my overall learning experience.	74.2%	3.6±1.1
3.I learnt how to evaluate a problem or issue by analysing different perspectives or viewpoints.	71.0%	3.6±1.1
4.The materials can motivate me to learn new things.	71.0%	3.6±1.1

Discussion and Implications

Our preliminary analysis suggested that the rubric was perceived positively by students in terms of its use as a marking scheme, enhancing transparency, objective grading, and provision of assessment criteria and performance descriptors. It generally helped them in

various aspects of their learning, such as understanding expectations, planning, preparation, assessment, and reflection. Alternative assessment could positively help them to learn, especially deepening learning, application of knowledge, evaluating and making judgement. Our students' feedback showed that they prefer alternative assessment (group project and presentation) over traditional tests/exams; at the same time, acknowledged that such assessment required more time and effort from them, when compared to traditional tests/exams. It appears that alternative assessment with detailed rubrics can enhance students' learning experience and understanding.

Conclusion

The study found that students' performance was higher in the F2F mode of delivery and that alternative assessment methods enhanced students' learning experience and understanding. In addition, 71% students found that the use of GenAI-empowered videos can enhance students' learning experience. Further research is needed to confirm these findings and explore their implications for science education in a post-pandemic context.

Limitations and Suggestions for Future Research

This study was conducted in one subject in two cohorts and with a small sample size. Further investigation is required to confirm the findings.

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