Adopting the Pedagogy of Trust and Its Impact on Learning

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Abstract—In this work, we present the results of our attempts to transit into a trust-based assessment environment for adult learners. The impact of utilizing an honour system of assessment throughout a course on data structures and algorithm design has been evaluated. The students' performance has been compared with the performance of students from two previous cohorts that appeared for the same assessments in an invigilated environment. We found that the performance variation between the test cohort and the reference cohorts was not significant with adult learners, who are more focused on learning the concepts to hone specific skills for applicability at their workplace. With further evidence of this promising initial step, we could evolve into a larger portfolio-based education framework in which students can showcase their competence and skills through a collection of projects and assessments (formative and summative), to help with their career growth. Establishing such pedagogies will help our students step out of their comfort zone, undertake exploratory studies, be willing to unearth their vulnerabilities, and work to improve their shortcomings to help them advance their careers.

Keywords—trust, formative assessments, summative assessments, honour system

1 Introduction

During undergraduate engineering education that spans around four years, a student typically takes 40-45 courses. The main objective of this training across a series of courses is to eventually graduate a competent engineer who can serve the needs of society. For quality and meaningful service in society, an engineer must have a high degree of competence. This competence is the primary goal of undergraduate engineering education. The onus is on both, the teacher and the student, to ensure that the gaps in the knowledge are identified and the student is adequately trained to be certified as a competent engineer to undertake engineering activities.

A standard practice of evaluating the student for competence is assessments. In each course, a student usually appears for various assessments, namely quizzes, tests, and exams. In addition to these, students also undertake lab activities and in-class activities,

and submit projects and assignments that form the basis to judge a student's understanding of various concepts.

With the emergence of the Covid 19 pandemic in early 2020, these stable modes of education were completely disrupted [1–9]. With the enforcement of the social distancing norms and the abrupt closure of the in-person mode of education, institutions around the world began to evolve and adapt to new realities [10–13] and new challenges [14–18]. Online learning became a new form of education that continues to be embraced globally [19–24]. Although numerous programs, particularly in the clinical setting, have had severe impediments with online learning, many programs, particularly in software engineering, in which hands-on lab activities do not exist, are continuing to operate in an online environment.

At McMaster University's W Booth School of Engineering Practice and Technology, the software engineering technology program has been an online program since 2017. Most of the students in this program are adult learners with a three-year college diploma and work experience. Most students in the program are working professionals and enroll in this program as part-time students. The courses are offered in the evening and on weekends to accommodate the students' work schedules. Also, for the convenience of the students, the course content is provided via live virtual lectures, and students report to the campus for summative assessments. However, these assessments have also continued in an online environment during the pandemic. As we emerge out of the pandemic, we aspire to continue with this online assessment which helps us cast our program as a truly online program, all the while maintaining the rigour and quality of the curriculum.

A significant impediment to this has been our traditional inclination to value only in-person closed-book closed-notes assessments, accepting that this alone establishes a quality program [25–27]. In other words, we are currently immersed in a culture where we do not trust our students and emphasize continuous verification and validation, which needs some evolution. This work addresses this research problem. As pointed out by Carless [28], without such an evolution, we are constrained in using innovative assessments that promote a better learning environment for our students. Student involvement in the assessments via group work and peer assessments could alleviate some trust-related issues [28,29]. However, there are concerns about 'free riders' in the former [30] and the trustworthiness of student marking in the latter [29], ultimately overshadowing the benefits of these assessment strategies. Nevertheless, some strategies to enhance trust include greater transparency about assessments, increased collaboration, and a more comprehensive assessment literacy that can help erase trust deficit [28].

To emerge out of the current status quo and embrace a more progressive educational environment that helps the students meet their educational needs to enhance their skills for career advancement, we present a preliminary investigation of an alternative assessment rooted in the philosophy of trust. Put differently; we want to transit into a culture wherein we trust our students and only randomly verify and validate. This work demonstrates that such an evolution is progressive and possible. Specifically, we explore the establishment of an honour-system-based assessment practice and compare the students' performance in such a system with the results from the previous cohorts that

appeared for similar assessments in an invigilated setting. Based on our findings, we present a proposition for the assessment protocols in the software engineering technology program at McMaster University. To the best of our knowledge, there is no comprehensive survey of the assessment protocols in the software engineering programs. As with other engineering courses, the courses in software engineering also employ formative or summative assessments, using a combination of quizzes, assignments, individual/group projects, tests and exams. In a recent investigation Sidhu et al compared two assessments techniques an undergraduate programming course to evaluate the efficacy of two strategies, namely, challenge-based and competency-based assessments [31].

2 Materials and methods

The Software Engineering Technology program at McMaster University is a degree completion program which admits students directly into level 3 of a 4-year undergraduate engineering program. Students are required to have a 3-year college diploma to be enrolled in this program. Thus, the program mainly attracts full-time working professionals interested in upgrading their college education. Algorithms and Data Structures is a third-year course at McMaster University's Software Engineering Technology Program, offered by W Booth School of Engineering Practice and Technology. The course topics include fundamental concepts, asymptotic analysis, sorting and order statistics, elementary data structures, advanced data structures and various graph algorithms. The expected learning outcomes from this course include: (1) the ability to undertake a theoretical analysis of an algorithm's performance, (2) Understand the principles of computational complexity, (3) Describe the organization of basic ADTs, and be able to implement ADT operations, (5) Use trees in applications such as searching, sorting, and selection, (6) Analyze and compare the performance of standard searching, sorting and selection algorithms, and (7) Describe the basic operations on graphs.

The course is offered over a 14-week duration, with the class meeting for a three-hour lecture each week. The lectures are completely virtual with live instruction. During the lectures, the students are introduced to the concepts and a variety of examples for the concepts are taken up. Among the various pedagogical techniques such as co-operative and small group learning [32,33], problem-based learning [34–40], inquiry-based learning [41], problem-solving based approach [42], project-based learning [43], active learning [32,33,44–49], and research-based learning [50–52], an active learning setting was employed in this course to enrich the learning environment. In this, students were frequently asked to engage in problem-solving sessions and undertake algorithmic analysis during the class. They are encouraged to discuss their solutions and collaborate with their peers, fostering a constructivist learning setting [38,53–55]. This is followed by discussions of solutions to the problems in which students actively engage with the instructor and their peers. The beginning of each lecture involves a quick recap of the materials covered in the previous week, and often some examples are reviewed to reinforce the material [46,56]. The lectures are fully recorded and are also made available

to the students at the end of the class through the online learning management system offered by the university.

The course involved a variety of assessments. Formative assessments include in-class discussions and quizzes. During the in-class activities, the interactions with the students were used to gauge the understanding of the concepts and to quickly calibrate the lecture either with more examples or by slowing down the pace of instruction, to ensure that the students understood the material. In the entire course, eight quizzes were administered to verify that the concepts were being well received by the students. Summative assessments included a midterm and a final exam. The quizzes accounted for 25% of the final course grade, whereas the midterm and final exams accounted for 30% and 45%, respectively, of the final course grade. The only data used in this study was the performance of every student in the individual assessment component of each cohort. The average class performance and the distributions of grades of students in each cohort in individual representative assessments have been used for our analysis and conclusions.

In the previous three offerings in the years 2019-2021, the course was delivered in an online format. However, the assessment of the exam varied. The quizzes were based on an honour system in which students were asked to take the quiz without any invigilation.

In 2019, the midterm and the final exam were conducted in an in-person environment. In 2020, these assessments were online but were invigilated on camera. On the other hand, in 2021, the midterm and the final exam were based on an honour system. Table 1 summarizes the characteristics of these assessments over the three years. In all three years, these summative assessments focused on the students' ability to apply the fundamental concepts to analyze and design problems, i.e., based on the higher levels of Bloom's taxonomy. For all three cohorts, the formats of assessments and the course's difficulty level were the same.

Table 1. The class size, the various assessments and their modes

Year	**2019**	**2020**	**2021**
# Students	36	34	48
# Quizzes	8	8	8
Invigilation Mode			
Quizzes	Honour	Honour	Honour
Midterm Exam	In person	On Camera	Honour
Final Exam	In person	On Camera	Honour

3 Results and discussion

The main motivation of this study is to determine the impact of the honour system on the quality of assessments. For this, we have studied performance of the students in the three types of assessments, namely, the quizzes, midterm exam, and the final exam, for the three cohorts from 2019-2021.

The students' performance from the three cohorts on each of the eight quizzes is shown in Figure 1. As seen in this figure, there are only minor fluctuations in student scores, and these variations can be attributed to the different student populations. A detailed distribution of grades in two representative quizzes is summarized in Table 2. As seen in this table, the students' performance in all three cohorts is very similar. The high percentage of students doing exceptionally well in the quizzes is attributed to the fact that the quizzes focus on their understanding of the basic concepts and contain very simple questions. Across both quizzes, the distribution of the grades and the consistency of the student performance across all three cohorts indicates no evidence of widespread collaboration, indicating the maintenance of the sanctity of the honour system. In other words, for any cohort, the variability of the percentage of students getting A grades in the two quizzes indicates that students are more focused on self-evaluation and understanding their shortcomings than collaborating and achieving a high grade. It is possible that towards the end of the course, the students chose to optimize their time by devoting more attention to some other course in which they are lagging.

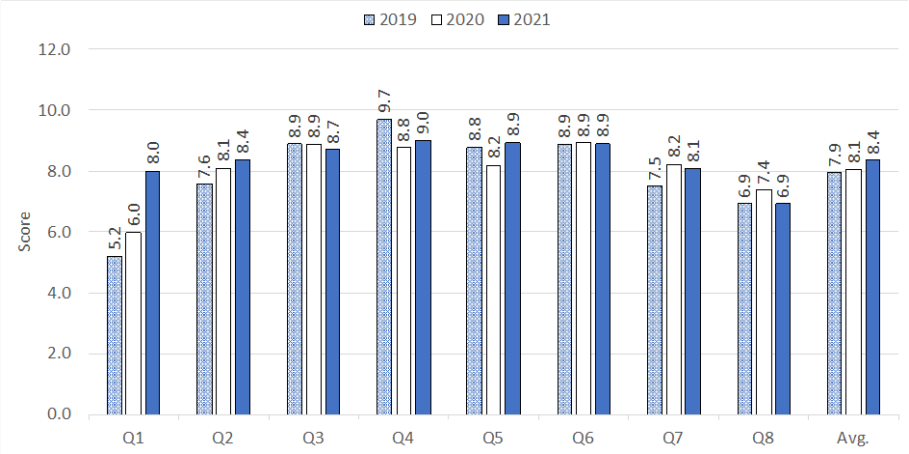

Fig. 1. Performance of the students from the three cohorts in the quizzes

Table 2. Distribution of grades in two quizzes

	Quiz 6 (%)			**Quiz 8 (%)**		
Grade Distribution	***2019***	***2020***	***2021***	***2019***	***2020***	***2021***
A	86	65	81	40	50	42
B	6	29	10	0	6	2
C	6	3	0	17	21	19
D	0	3	6	29	6	15
F	3	0	2	14	18	23

While the honour system seems to be working well for the quizzes, these are fairly low-stakes assessments with a combined weight of just 15%. The students' performance in two high-stakes assessments, namely, the midterm exam and the final exam, is shown

in Figure 2a. This figure also includes the average course grade in the three cohorts. As seen in this figure, with an average score of about 58% in the final exam, the performance of the 2019 and 2021 cohorts was similar. This low average score on such a high-stakes assessment gives adequate confidence that the honour system in the course worked without any notable issues. The distribution of the grades in the final exam is shown in Figure 2b. As seen in this figure, the grades show a normal distribution, with about 40% of the 2021 cohort getting a C grade reflecting the 58% average in the final exam.

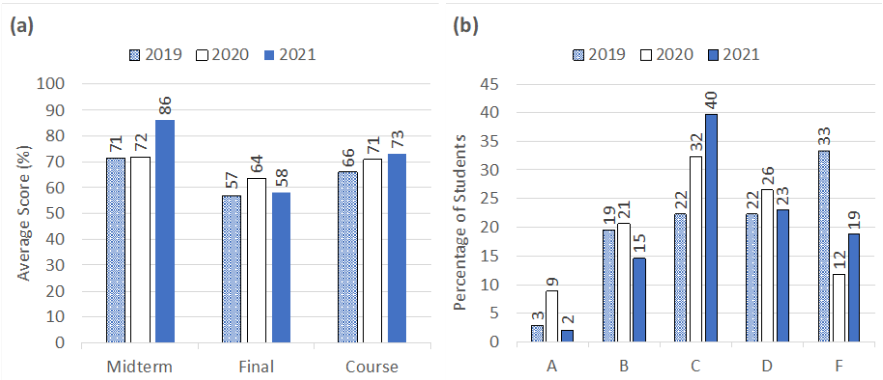

Fig. 2. (a) Average score of the students in the midterm and final exams and the final course grade. (b) Distribution of grades in the final exam

On the other hand, there is a sharp rise in the midterm grade of the 2021 cohort. This could be attributed to the fact that unlike the 2019 and 2020 cohorts, the 2021 cohort had access to sample midterm exams for review. Historically, in this department, the students have significantly benefitted and have performed well when they have received such a review package for a high-stakes assessment. We are confident that this high average cannot be attributed to any extensive collaboration or compromise of the honour system because the final exam grades would betray such a situation. Finally, the high average in the midterm resulted in an increase in the students' overall grade in the 2021 cohort.

In general, this data from the 2021 cohort and our expectations of the results based on our interactions with the students in the classroom are consistent. As expected, we have not found any evidence of flouting the honour system. Consistent with the observations in the literature, this is attributed to the fact that an overwhelming majority of the students in this program are adult learners. Such learners are typically characterized as: (1) working professionals who enrol in part-time education, (2) have dependents to support, (3) show flexibility in academic and professional advisement, and (4) are constrained by time limitations [57,58]. Often, such learners are highly motivated, achievement-oriented, and relatively independent [58]. These students are usually interested in obtaining specific skills and competencies that are detrimental to the advancement of their careers [58,59]. This is consistent with the observation of Cullity [60] who found that mature students may come from different education backgrounds but have a strong

desire to participate in higher education. These students show a strong inclination to active and experiential approaches to learning and value opportunities to integrate academic learning with their work [61]. In his investigation, Stevens [58] found that these lifelong learners were motivated by a rigorous education that was useful to them in their careers. They also wanted to set an example for their children and inspire them to be lifelong learners. In other words, the students enrolled in programs like ours are more interested in learning the concepts and value the key learning outcomes to apply this at their workplace to enhance their life opportunities and outcomes.

Our study also has some deficiencies: We cannot conclusively establish that there was absolutely 0% collaboration. There is a small possibility that some students might have collaborated in violation of the honour system. However, a comparison of the data from the different cohorts administering different assessment environments shows that the grade distributions are very similar. This indirectly implies that there is no evidence of any collaboration. The philosophy seems to work because the class is dominated by self-motivated adult learners whose outlook toward education is very different. We cannot determine if this would be true in a program where the students are joining at a much tender age and do not have the same level of maturity.

Where can we go from here? The findings from this work point that in the software engineering technology program at McMaster University, which is predominantly characterized by adult learners, the initial steps towards a more progressive learning environment are very promising. We intend to establish this conclusion rather firmly by undertaking such an experiment with several technical courses in Winter and Summer of 2022. Initial trends from the current terms indicate that the findings from this research will hold. This sets us up for the more elaborate change in Fall 2022, wherein we plan to introduce a portfolio-centric education with a collection of several projects demonstrating the application of the concepts to design and create software solutions. Additionally, the portfolio will also include a short collection of formative and summative assessments, adequately demonstrating a student's competencies in the subject.

4 Summary and conclusion

In this study, we have taken an initial step towards introducing a culture of trust in the program to propagate a more nurturing learning environment that will help our students identify their shortcomings and help them improve their skills and competencies to advance their careers. Specifically, we explored the establishment of an honour-system-based assessment practice and compared the students' performance in such an environment (test cohort) with the results from two previous cohorts (reference cohorts) that appeared for similar assessments in an invigilated setting. The study was conducted for a single course in which the concepts of data structures and algorithm design were taught over 14 weeks.

A comparison of the three cohorts (the test cohort of 2021 and the reference cohorts from 2019 and 2020) indicate no significant variation in the average scores of the students across eight formative assessments and two summative assessments, irrespective of whether they took the course in an honour system or an invigilated environment. The

only anomaly was the midterm score, that was higher by about 14% in the test cohort. However, we believe this is because the test cohort had access to sample exams to help them prepare better. The reference cohorts did not have access to such tests. The strongly weighted comprehensive final exam showed that the test cohort performed relatively poorly, assuaging any concerns of collaboration during any of the assessments. Note that the final exam was summative, in which students were required to apply algorithms to data sets, determine the running times of algorithms, and demonstrate the application of stacks and queues to store and retrieve data. The average course grade of all three cohorts was within statistical variation and could be attributed to the variation in the sample population.

From these results, we conclude that the proposition of establishing a culture of trust between the students and the instructor to improve the learning environment is not going to vitiate the assessment environment and, thereby the quality of the learning outcome. The positive outcome that we have observed is primarily attributed to the fact that most of the students in the program are adult learners who are genuinely interested in learning the concepts and improving their skills to apply them at their workplace to advance their careers. In other words, the approach presented in this work could apply to courses and programs characterized by such students. This initial success has shown that as we move forward, by trusting our students and allowing them to explore and express their vulnerabilities through a portfolio-based education focusing on a collection of projects and assessments to demonstrate competence, we would be well-positioned to promote a healthy learning environment.

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