Digital Imaging Applications or Fabrications: Preserving Academic Integrity in a Geomatics Engineering Technical Elective Course

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Keywords: Pedagogy, Engineering education, Project-based course, Group work, Plagiarism, Artificial intelligence (AI).

Abstract

Project-based and group work oriented courses can be used to prepare engineering students for professional practice. At the same time, these course formats present increased risks related to academic integrity. This paper presents a case study of the "Digital Imaging & Applications" course, a fourth-year technical elective in the geomatics engineering program at the University of Calgary, which contributes to both the professional engineering and surveying accreditation requirements. Following two post-pandemic offerings in which serious breaches of academic integrity were identified, this paper examines pedagogical and structural factors that contributed to these outcomes. These included insufficient prerequisite alignment for certain students, imbalanced group formation, reduced engagement associated with a no-exam assessment model, and delayed identification of problematic submissions. Current institutional policies and procedures governing academic misconduct are summarized to provide organizational context. A set of preventative and mitigation strategies was proposed and partially implemented in a subsequent course offering. These included revised prerequisites, increased assessment through low-stakes quizzes, instructor-guided and rotating group formation, formalized group contracts and peer evaluation, and stricter differentiation of project datasets. The benefits and limitations of these measures are discussed. This paper concludes that preserving academic integrity in advanced, project-based engineering courses requires a layered and proactive instructional approach that balances authentic learning, accreditation requirements, and institutional constraints.

1. Introduction

This is a paper on best pedagogical practices in engineering education. In particular, the paper will focus on a project-based course involving group work. The course is taught at the University of Calgary, and is part of the geomatics engineering program. Post pandemic, the course has been fully run twice and at the time of writing is being run for the third time. In the first two iterations, there were serious breaches of academic integrity. This happened even though reasonable measures to prevent cheating had been put into place. The aim for the current and any future offerings of the course would be to preventatively tighten those measures and in the unfortunate scenario that cheating happens again to explore tools for its early detection. In addition, the paper provides information on two of the accreditation organizations related to geomatics engineering in Canada. It also summarizes the current versions of two of the University of Calgary documents related to academic misconduct. Note that due to privacy protection regulations, details related to the actual misconduct cases cannot be described in this manuscript.

2. Background

The course in question is called "Digital Imaging & Applications". It is a last-year technical elective in the geomatics engineering degree program at the University of Calgary. This geomatics engineering program is accredited by both the Canadian Engineering Accreditation Board (CEAB) and the Canadian Board of Examiners for Professional Surveying (CBEPS). The next two sub-sections will provide details on these two accreditation, while the sub-section after that will describe how the course serves these accreditations.

2.1 Engineering Accreditation

Engineers Canada is an organization that represents the profession of engineering at the national level in Canada. It is a federation of multiple provincial/territorial engineering regulators. One of its core tasks is to accredit undergraduate engineering programs in Canada (Engineers Canada, 2007a). This is done via one of its committees, namely the Canadian Engineering Accreditation Board (CEAB) (Engineers Canada, 2007b). Any graduate from an accredited engineering program satisfies the academic requirements for their professional engineering (P.Eng.) licensure so they are able to commence the licensure process upon graduation. CEAB looks at both graduate attributes and accreditation units when assessing a program.

The graduate attributes, which can be seen as high level learning outcomes or competencies, are the following (Engineers Canada, 2026):

1. Knowledge base for engineering – applying math and sciences to the practice of engineering
2. Problem analysis – solving complex engineering problems
3. Investigation – conducting experiments to reach valid conclusions
4. Design – coming up with a solution that meets certain standards and specifications; may have to be done iteratively
5. Use of engineering tools – using modern tools such as certain hardware and/or software

6. Individual and team work – working effectively either individually or as part of a team
7. Communication skills – being able to explain complex concepts in written, oral or graphical form
8. Professionalism – recognizing the roles and responsibilities of a professional engineer to the public
9. Impact of engineering on society and the environment – analysing how engineering activities may affect society and the environment
10. Ethics and equity – making appropriate choices when faced with ethical dilemmas
11. Economics and project management – incorporating business practices and project management in engineering work
12. Life-long learning – continuously addressing personal learning needs in a rapidly changing world

Note that the list of graduate attributes can be divided into two categories: 1) technical / hard skills (namely #1 to #5), and 2) soft skills (namely #6 to #12).

Each learning outcomes for a particular course is linked to one of the twelve graduate attributes. The assessment(s) for any particular learning outcome serve as (a) measurement(s) for the corresponding graduate attribute. The graduate attributes can be at the introduction (I), development (D), or application (A) level (Engineers Canada, 2026).

The accreditation unit areas are the following (Engineers Canada, 2026):

- Mathematics (e.g., calculus, linear algebra, probability and statistics, numerical methods)
- Natural sciences (e.g., physics)
- Engineering science (e.g., signal processing)
- Engineering design (e.g., integrated solutions to meet standards and specifications)
- Complementary studies (e.g., economics, impact of technology on society and the environment, communication, project management)

Each program course contributes content for one or more of the accreditation unit areas. The contribution distribution is allocated with a percentage. Overall, each program needs to have a minimum number of credit hours or units for each of the areas listed (Engineers Canada, 2026).

2.2 Land Surveying Accreditation

In Canada, CBEPS or the Canadian Board of Examiners for Professional Surveying is responsible for accrediting university and college land surveying programs. A program can be fully or partially accredited. If a program is fully accredited, its graduates have the option to receive the CBEPS certificate of completion depending on their technical and complementary studies electives. Once the certificate of completion is received by an individual, they can start the articling process for a land surveying licence in their particular jurisdiction. If a program is only partially accredited, then its graduates would be waived certain courses or portion of the CBEPS curriculum, but will have to challenge exams or take more courses at other institutions in order to obtain the certificate of completion. The CBEPS curriculum is currently undergoing changes. The old curriculum has twelve compulsory and one elective subjects (CBEPS, 2023a). Note that each subject corresponds to the equivalent of one or more university / college courses. The twelve compulsory subjects are the following (CBEPS, 2023a):

- C1 – Mathematics
- C2 – Least squares and data analysis
- C3 – Advanced surveying
- C4 – Coordinate systems and map projections
- C5 – Geospatial information systems (GIS)
- C6 – Geodetic positioning
- C7 – Remote sensing and photogrammetry
- C8 – Cadastral studies
- C9 – Survey law
- C10 – Land use planning and economics of land development
- C11 – Business practices and the profession
- C12 – Hydrography

In addition, students need to satisfy the requirements for one of the following elective subjects (CBEPS, 2023a):

- E1 – Spatial databases and land information systems
- E3 – Environmental management
- E4 – Advanced remote sensing
- E5 – Advanced photogrammetry

The old curriculum is being phased out, but it is still valid until 2026. In the mean time, a new CBEPS curriculum was started, namely “The 2023 National Syllabus” (Bolkas et al., 2023; CBEPS, 2023b). The new curriculum is divided up into eight sections:

- S1 – Mathematics and science (i.e., calculus, linear algebra, statistics, physics, computer programming, etc.)
- S2 – Modelling and analysis (i.e., least squares estimation, data analysis, etc.)
- S3 – Geodesy (i.e., reference frames, datums, coordinates systems, GNSS positioning, etc.)
- S4 – Surveying (i.e., field methods and instrumentation, survey design, etc.)
- S5 – Remote Sensing (i.e., satellite remote sensing, photogrammetry, LiDAR, hydrographic surveying, etc.)
- S6 – Geospatial information systems (i.e., geospatial analysis, visualization, database design, etc.)
- S7 – Law, tenure, boundaries, cadastres, and planning (i.e., land registration systems, real property and survey law, land use planning, etc.)
- S8 – Professional practice (i.e., professional ethics, business practices, communication, project management, etc.)

The new system is centred around competencies. In order for a certain section to be accredited, its competencies must be met in one or more courses offered in a particular educational institution. As CBEPS is accrediting the various programs in Canada, it is updating the list of courses in certain institutions that fulfill the requirements for the sections (CBEPS, 2024).

2.3 The Course

The “Digital imaging & applications” course is a fourth/last year technical elective, and it is offered in the very last semester of the program. Its learning outcomes are as follows (note that the graduate attribute number and its level are listed in square brackets):

- Explain image analysis concepts including: basic characteristics of digital image data; information in digital images, image segmentation; description and matching of two-dimensional image objects, description and modelling of three-dimensional image objects. [1; A]
- Design viable digital image processing algorithms for solving diverse engineering problems. [4; A]
- Construct logical, coherent, and concise written reports that describe engineering design solutions and follow a prescribed report format. [7; A]
- Demonstrate effective use of charts, graphs, figures and tables to illustrate your design and data analysis. [7; A]
- Write MATLAB or Python source code that adheres to prescribed programming practices. [5; A]
- Explain the social, economic and environmental relevance of diverse engineering design problems, in the context of digital image analysis. [9; I]
- Set expectations for team work and brainstorm conflict resolution mechanisms in order to successfully reach a team goal. [6; A]
- Propose two or more feasible alternative solutions to an engineering problem; state their pros and cons. [2; A]

In terms of accreditation units, the course content is divided up into 25% engineering science, and 75% engineering design. That does not mean that the rest of the accreditation unit areas are not covered, but that the new content and assessment primarily focus on these two areas.

Under the old CBEPS curriculum, this course contributes to parts of "E4 – Advanced remote sensing". For the new CBEPS syllabus, this course falls under "S5 – Remote sensing".

The course was designed by an engineering professor to transition students from academia to the "real world". First, it was a project-based course, i.e., all assessment was based on student performance in four projects. Each project submission included a project report, the source code for the project solution, and any associated input/output. There were no traditional exams. Second, the projects were done in groups of two or three students. This served to emulate typical teamwork in the geomatics engineering industry.

Since 2024, the course has also been cross-listed as an elective for course-based master's (or MEng) students. The pre-requisites for the undergraduate students are a course on signal processing and a course on remote sensing. On their end, these courses have various computer programming and math courses as prerequisites. Originally, there were no prerequisites for the MEng students. In order to support the students in their project implementation and in their studies in general, traditional lectures introducing base- to high-level digital image processing concepts and techniques were taught and sample source code was uploaded on the learning management system for the students to use. When it comes to the solution for a particular project, students are allowed to use standard functionality in MATLAB / Python or even third-party libraries so long as they are properly referenced.

3. What Went Wrong

In the 2024 and the 2025 iterations of the course the following issues occurred:

- since there were no prerequisites for the MEng students some of them may have enrolled in the course with insufficient background knowledge and skills;
- since the lecture slides and the sample source code were shared with the students and they were not tested in a typical exam setting, attendance for both the lecture and the lab periods dropped considerably halfway through the offerings;
- due to the relatively large class size, students were allowed to form their own groups, which may have potentially led to a lack of balance in the overall background and skillset of some of the groups;
- ultimately, some of the students / groups were investigated for academic misconduct and due to the sanctions imposed on them they either withdrew from the course or received a non-passing grade.

The main issue here was the academic misconduct allegations, the extra work load and stress associated with the investigation for all parties involved, and the overall negative outcome for the students. This is why the following two methodologies were proposed in order to prevent academic misconduct from happening or automatically detect it if it does happen.

3.1 Proposed Preventative Measures

The following preventative measures were planned for the 2026 offering of the course:

- introduce one or more prerequisite courses for the MEng students;
- possibly introduce team-based learning (TBL) activities such as individual and group-based quizzes before each project with the project being the application of the concepts being tested;
- students will fill out a questionnaire and groups will be formed by the instructor such that each group will be well-rounded in terms of background and skillset;
- different groups will be required to work with different imagery and/or different excerpts of the same satellite scene.

3.2 Proposed Plagiarism Detection

In an ideal case scenario student submissions will be run in some sort of a plagiarism detection tool such as a correlator. This way, any red flags will be raised early enough, and there will not be any delays in grading / returning the grades to the students who did their own work. Also, if any students are sanctioned, hopefully this will be done early enough so that the same mistakes are not repeated in the submissions to follow.

4. Academic Misconduct Documents

Before delving into the implemented solutions for the problem at hand, it is important to summarize two of the University of Calgary documents related to academic misconduct. The first one is the "Student Academic Misconduct Policy", and the second one is the "Student Academic Misconduct Procedure".

4.1 Academic Misconduct Policy

In short, the “Student Academic Misconduct Policy” defines academic misconduct and its implications (Bancroft, 2020a). The following are given as examples of academic misconduct:

- Cheating (e.g., copying, etc.)
- Fabrication (e.g., making up data)
- Falsification (e.g., manipulating data)
- Plagiarism (i.e., not crediting someone else for their work)
- Unauthorized assistance
- Failure to follow instructor expectations / registrar exam regulations

The severity of sanctions depends on the intent, prior misconduct, gravity of offence, etc. Possible sanctions may include:

- Attending a workshop on academic integrity
- Grade reduction, zero on assessment, or failure in course
- Disciplinary probation, suspension, or expulsion

4.2 Academic Misconduct Procedure

The other university-wide document related to academic misconduct is the “Student Academic Misconduct Procedure” (Bancroft, 2020b). This document lists the steps for reporting and investigating any potential academic misconduct. The timeline and deadlines for each step are also of importance especially if the case goes onto an appeal. Here are a few important notes:

- While anybody can report a potential case of academic misconduct, typically it is the course instructor who carries the burden of filling out a written report and gathering any evidence;
- If the written report and evidence is escalated to the appropriate associate dean, the matter can be dismissed or further investigated;
- The ground(s) of the allegations together with the evidence is shared with the student(s), and they are given the opportunity to respond to the allegations and submit any other evidence;
- Note that while the student(s) is/are allowed to bring an advisor to the meeting with the associate dean, the instructor is not allowed to attend (or get involved in any other way for that matter);
- The associate dean makes the final decision (i.e., whether the case constitutes academic misconduct and what the sanction should be is decided by a single person) on the balance of probabilities; the decision is based on the presented information only and no further investigation is to be conducted;
- The entire process is documented and a decision letter is sent to the student(s) affected; the instructor should also be notified so that they know what grade to assign to the student(s);
- The student is typically allowed to appeal the decision, while the instructor is not;
- The instructor is not allowed to discuss the matter with the student(s); when pressured by the student(s) about their pending grade(s), all the instructor is allowed to disclose is that the assessment in question is “under review”.

5. Implementation of Course Changes

In the 2024 and the 2025 iterations of the course, student assessment was based on four projects, each worth between 20% and 30%. The student submissions included a technical report and the implemented source code (with any necessary input and corresponding output). The source code had to follow a certain style, and needed to include both header and inline documentation. The technical report had to include the following components:

- Title page
- Table of contents (including lists of figures and tables)
- Executive summary
- Introduction / background
- Problem definition
- Alternative solutions
- Detailed design
- Results and discussion, and
- Summary and conclusions

The four projects are as follows:

- Project #1: detecting and tracking a ball in a series of video frames; the theme is related to sports entertainment
- Project #2: counting dwellings in a satellite scene; the theme is related to humanitarian help
- Project #3: matching moving ice features in consecutive satellite scenes; the theme is related to climate change / environmental protection
- Project #4: segmenting brain lesion in magnetic resonance imaging of stroke; the theme is related to (bio)medical solutions

Some of proposed preventative measures were implemented in the current offering of the course, i.e., the one for the 2026 winter semester. However, some of the proposed measures were either not implemented or only implemented partially.

5.1 Implemented Preventative Measures

The following preventative measures were implemented (see Table 1 for a summary):

- A course in photogrammetry or remote sensing/GIS was listed as a prerequisite for the MEng students; this was suggested in 2024, but took effect in 2026, because the process of making changes to the calendar description of a course usually takes effect with a one-year lag;
- The assessment was restructured so that each project is now worth 25% of the final grade, where 80% (or 20% in total) goes towards the technical report and sources code implementation, 4% (or 1% in total) goes to a group contract, 14% (or 3.5% in total) goes towards a quiz, and 2% (or 0.5% in total) goes towards peer evaluation (see Figure 1); the real big change here was running a quiz for every project; while this brought some extra structure and pedagogical rigour to the course, it did defeat the “no exam” aspect of the course design; also, the team-based learning (TBL) aspect of the quiz was not implemented at this time; the quizzes consisted of true/false/multiple choice questions, and were run in

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the learning management system (LMS) in-person and synchronously; while true/false/multiple choice questions are not the most effective way of assessing learning, they were graded automatically in the LMS and thus did not increase the grading load for the course;

- Students filled out a questionnaire and the instructor formed the groups partially based on the information provided; the idea was that each group will be well-rounded in terms of background and skillset; in reality, the information provided in the questionnaire was insufficient to gauge students’ prior knowledge and skills; thus, it was decided to generate new groups for each of the projects; it was done on a rotational basis, where one student in each group was swapped out to another group for every new project; the intent was to keep students accountable with their group mates; this was not an easy task and it risked causing other headaches such as “cross-pollination” between the groups; the contracts and the peer evaluations were there as conflict resolution mechanisms; for example, in each of the contracts the group members are asked to specify their expectations and brainstorm ideas of how to resolve an issue between group members; the students are also asked to date and sign under their name just like in a real-life contract;
- Different groups were assigned a different sub-set of the overall data provided or they were asked to crop out their own excerpts of the satellite scene provided; this rule was listed in the project handouts and was strictly enforced in terms of the deliverables; for example, in the first project each group was assigned 20-40 different video files to work with; another requirement was to have a sample data set as a “scratch pad” used for the development of the algorithm, i.e., characterizing the objects of interest and fine tuning any thresholds, while the rest of the data was used for testing the developed algorithm independently.

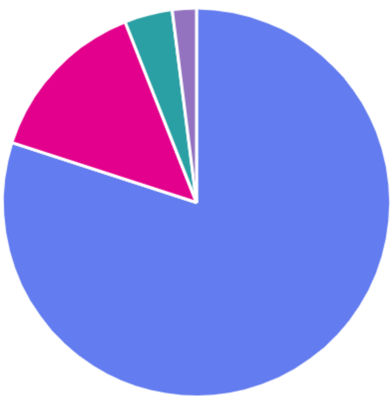

Figure 1. Course assessment structure: project reports in blue; quizzes in red; contracts in teal; and peer evaluations in purple

5.2 Constraints

The output from a plagiarism correlator can serve as an early starting point for an investigation if necessary. However, it cannot be used as a proof for academic misconduct directly. Due to this limitation and due to time restrictions, this idea has not been investigated for the time being.

Aspect	Before (2024 & 2025)	After (2026)	Expected impact
Prerequisites	No prerequisites for MEng students	Enforced prerequisites (photogrammetry / remote sensing)	Improved baseline knowledge and reduced skill gaps among students
Group formation	Self-selected groups	Instructor-guided and rotating groups	More balanced teams and increased individual accountability
Assessment structure	Projects only	Projects with integrated low-stakes quizzes	Increased engagement and continuous monitoring of learning
Dataset management	Shared or overlapping datasets	Differentiated datasets across groups	Reduced opportunities for copying and unauthorized collaboration
Student engagement	Low attendance and participation	Increased (albeit forced) attendance due to quizzes	Higher engagement
Detection of misconduct	Late detection of issues	N/A	N/A

Table 1. Comparison of course design measures before and after interventions (with expected impact)

6. Summary and Conclusion

This paper examined academic integrity challenges in a project-based, group work oriented technical elective course in geomatics engineering at the University of Calgary. The course is designed to support professional transition from academic studies to industry work while fulfilling both engineering and surveying accreditation requirements in Canada. Despite reasonable preventative measures, serious cases of academic misconduct occurred in the 2024 and 2025 offerings, resulting in negative academic and administrative consequences for all parties involved.

Several contributing factors to the observed misconduct were identified, including insufficient prerequisite enforcement for MEng students, voluntary group formation leading to imbalanced teams, reduced engagement due to the absence of traditional examinations, and delayed detection of problematic submissions. In response, multiple preventative measures were proposed, with a subset implemented in the 2026 offering. These included introducing formal prerequisites, restructuring assessment to include low-stakes quizzes, instructor-guided and rotating group formation, structured group contracts and peer evaluations, and stricter differentiation of project datasets across student groups.

In conclusion, preserving academic integrity in an advanced, project-based engineering course requires a multi-prong approach that combines prerequisite alignment, structured assessment, deliberate group formation, and early misconduct detection strategies. While no course design can fully eliminate misconduct, proactive instructional design can hopefully reduce its likelihood and impact. The experiences listed here may be informative for instructors delivering similar upper-year, collaborative courses in geomatics engineering and related disciplines.

Acknowledgements

The author would like to thank one of the previous course instructors, Dr. Michael Collins, for designing the course and sharing the teaching materials. Also, the author would like to thank the teaching assistant, Arash Mozhdehi, for helping with the academic misconduct paperwork in addition to his regular duties.

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