

WORKFLOW COMPARISON:

Crowdmark Grading vs. Traditional Grading

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This white paper by Crowdmark

- maps the workflows to perform traditional paper grading and Crowdmark grading;
- quantifies time savings resulting from grading with Crowdmark;
- identifies key benefits of Crowdmark;
- analyzes each task in both workflows to uncover additional findings.

Acknowledgements

The research described in this paper was carried out as part of an academic-industrial collaboration project with University of Toronto Institute for Multi-disciplinary Design and Innovation's Centre for Operational & Performance Excellence (IMDI-COPE) at the University of Toronto. The project explores how online collaborative grading streamlines engineering accreditation. Crowdmark thanks Marko Damnjanovic and Professor Dionne Aleman of the University of Toronto for their contributions to this line of research.

Mapping the Workflow

The workflows to grade paper based assessments in both Crowdmark and through traditional methods were broken down into business process maps (see Appendix A). Additionally, a detailed process map showing more decomposed tasks is shown in Appendix B. It is important to note that this report's scope of a traditional workflow is one associated with administering an exam which students write by hand at a designated time and exam room.



Benefits

The benefits offered by Crowdmark can be divided into 3 areas – time savings, convenience gain, and reduction of errors. Using the same tasks as shown in the business process maps, Figure 1 shows the benefits gained with each major task in the workflow.

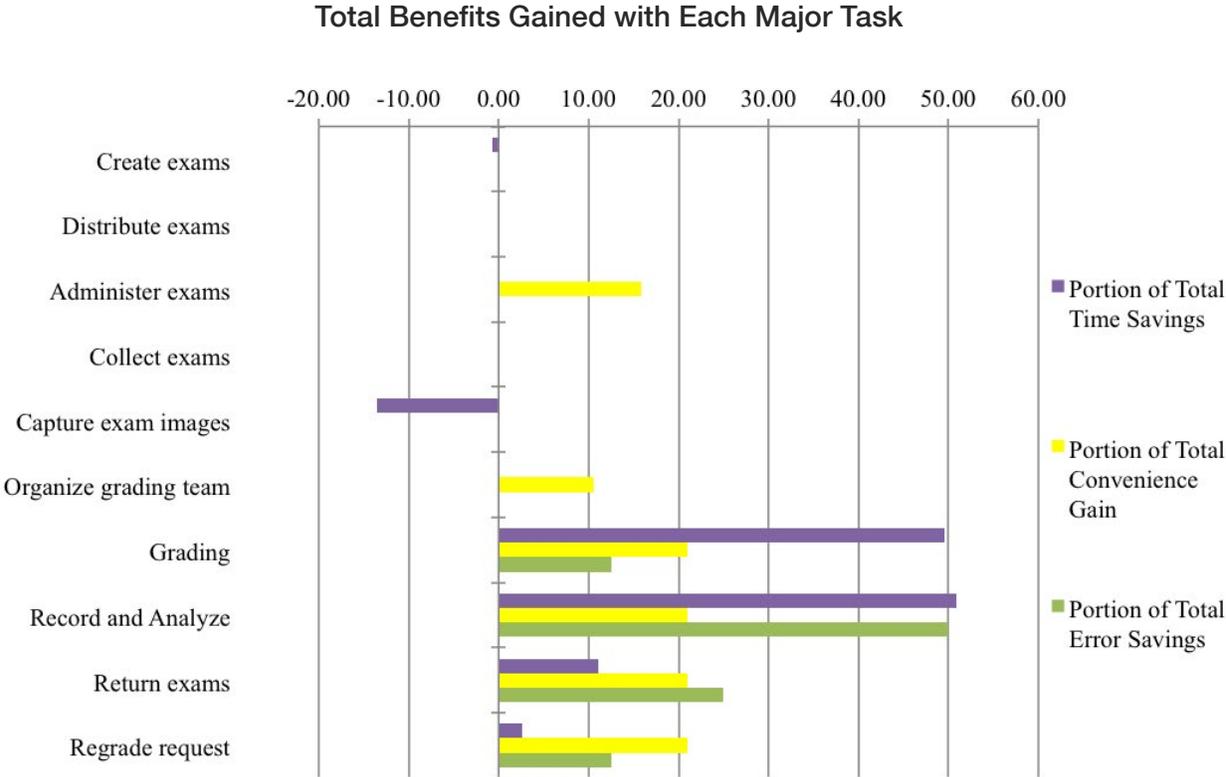


Figure 1 – Percentage distribution of benefits by task. This data is representative of a 1000 person exam with 10 questions per exam. The negative percentages indicate tasks that do not provide time savings, but rather require excess time compared to the respective task in the traditional workflow.

Time savings

Time savings in grading, recording, and analyzing student performance are the most salient benefits that Crowdmark provides.

By investing time in uploading the exam template to the Crowdmark platform, scanning completed exams (outsourced or in-house), and matching assessments to students, overall grading time can be reduced to 25% of traditional grading time. The main source of these time savings results from the elimination of logistically intensive tasks such as paper shuffling, data entry, and disseminating exams.

To complement the business process mapping done earlier, Figure 2 shows the portion of total time savings occurring for each major task in the workflow as the number of exams increases.

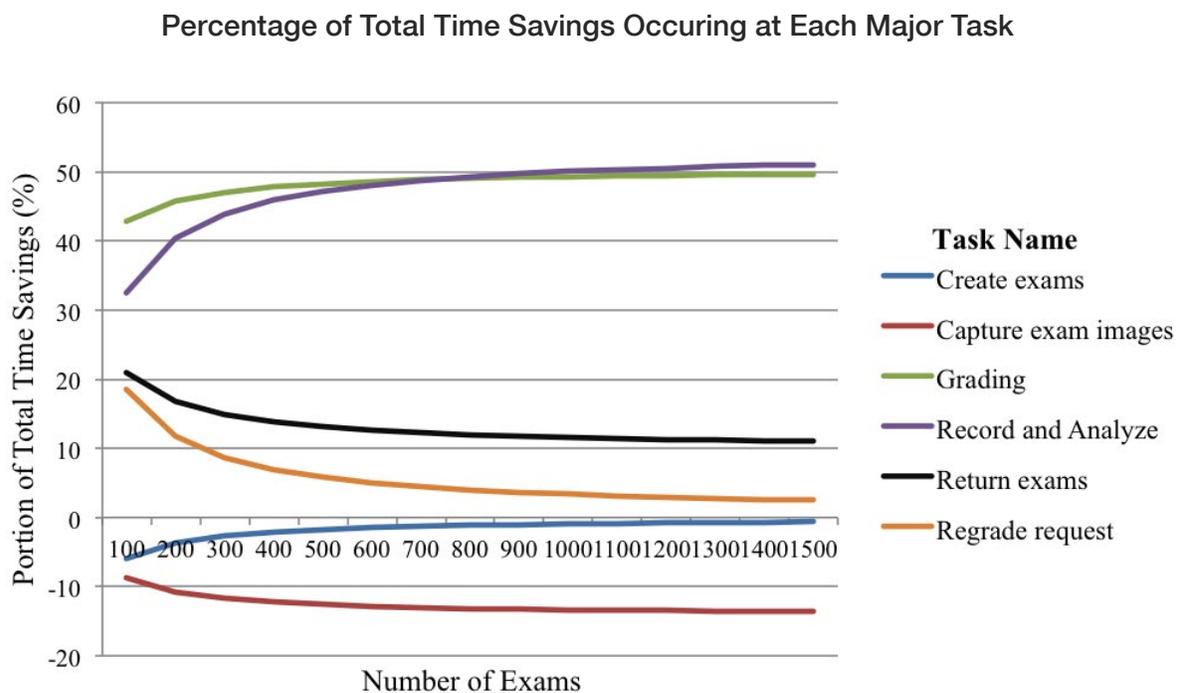


Figure 2 – Percentage of time savings occurring at various stages of the workflow as the number of exams changes.

Findings interpreted from Figure 2

1. When the number of exams is small (100-200), the tasks of returning exams and re-grading are each responsible for about 20% of the total time savings. As the number of exams increases, these tasks contribute much less to the total time savings, with returning exams and re-grading accounting for only 10% and 5% respectively.
2. The task of grading is the biggest source of time savings when the number of exams is less than 800, contributing about 42-50% of the total time savings.
3. Recording and analyzing is a task that is automatically completed in Crowdmark; this potency is most prominent as the number of exams rises. With an increasing number of exams, this task becomes a larger contributor to the total time savings, rising from 32.5% to 50%. After 800 exams, recording and analyzing becomes the biggest contributor to total time savings, slightly edging out grading by a couple of percentage points.
4. The excess time involved in creating exams originally decreases the total time savings by almost 10%. However, due to the consistent time required to create an exam, this task only reduces the time savings by 3% or less when the number of exams grows – clearly showing that it is an efficient investment in time.
5. Capturing exams images originally reduces the total time savings by about 10% as it requires excess time to scan exams when compared to the traditional workflow. As the number of exams rises, so does the reduction of total time savings, but it plateaus at about 13%.

But is all of this time saving taking work away from TAs?

Yes, the logistically intensive work that no one wishes to do. If TA hours must be reallocated, redirecting them toward additional office hours would be compatible with the increasing student demand for one-on-one teaching.

Convenience Gain

Crowdmark improves the grading experience by providing the multiple convenience benefits listed below.

Location

The paper to cloud bridge provided by Crowdmark enables graders to evaluate assessments on an Internet connected device in any remote location. Traditionally, graders are constrained to a specific location typically assigned by the grading facilitator. This is because traditional grading incorporates a sequential workflow requiring graders to interact with physical copies of the exam one at a time. As a result, facilitators are forced to assign all graders to meet at a specific location and time with a strategy of streamlining the exchange of papers from one grader to another.

Time Flexibility

As mentioned previously, graders are often forced to grade at a specific time and location. However, with Crowdmark's parallel workflow and digital copies of exams, graders have the flexibility to complete grading whenever they wish. Figure 3 displays the distribution of times that graders perform their grading using data from multiple Crowdmark graded midterms that required 70 total grading hours.

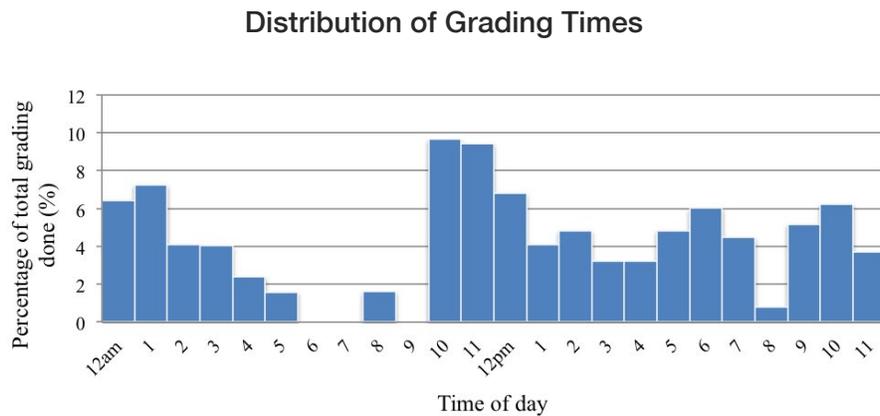
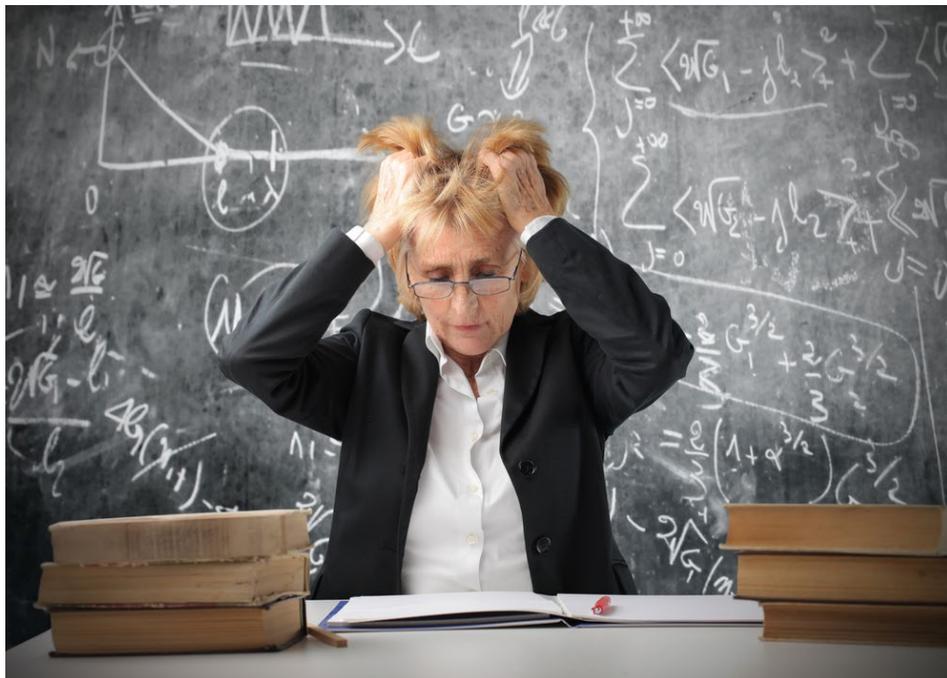


Figure 3 – Distribution of the time that graders perform their grading through Crowdmark. Clearly, the grading period is not congested into a scheduled time slot like traditional methods, allowing graders to complete their grading on their own schedule.

Reduction of Errors

By streamlining the grading workflow, Crowdmark also eliminates tasks which are susceptible to human error.

Such frequently erroneous tasks include data entry, alphabetizing, test disseminating (transporting to wrong tutorial room), or test exchange amongst the graders. Additionally, having a digital copy of the exams eliminates any cases of lost or misplaced exams.



Task Analysis

This section will focus on evaluating each major task and uncovering additional findings.

Create exams

In Crowdmark, an exam template is uploaded to the web platform in order for a QR code identifier to be added to each page. After uploading and automatic modification of the exam by Crowdmark, the file is downloaded for printing purposes. The typical file size of the exam file is 1.5mb per 1000 pages, meaning that downloading of the exams does not take a considerable amount of time with a reasonable internet connection. As mentioned in the previous section, the time investment involved in creating an exam initially reduces the time savings by nearly 10% when the number of exams is small, but becomes nearly negligible (<1%) as the number of exams grows past 500.

Distribute exams

The distribution of exams is similar in both workflows; the only major difference is that Crowdmark exams must be printed individually rather than photocopied because of the unique QR codes allocated to each exam.

Administer exams

Crowdmark's workflow in administering exams provides convenience benefits. These benefits arise in the instance that a Crowdmark application is used to take attendance and confirm student identity, rather than the traditional paper-checklist method.

Collect exams

The collection of exams by the facilitator is the same in both workflows, with invigilators strategically walking around the exam room to collect each individual paper exam.

Capture Exam Images

The task of scanning assessments provides the paper to cloud bridge which allows Crowdmark to offer many of the aforementioned benefits. However, the task itself can appear very cumbersome, especially for exams with 1000+ students. Crowdmark has both outsourced scanning to professional services and relied on TA's or grading facilitators to do it in-house. The contrast between the two methods is highlighted below.

Outsourcing

- Courier picks up paper exams at a specified time and place
- Professional service, meaning there are no errors in scanning
- Crowdmark uploads the scanned assessment to the platform and notifies the grading facilitator when the exams are ready to be graded. This step is done to minimize the amount of work the facilitator has to do, and to prevent any uploading problems due to a slow network connection (scanned exam files could be very large)

In-house

- Grading facilitator takes the paper exams to a scanning station
- The typical scanning rate is 1000 pages per hour
- Scanning is performed by TAs or administrative employees, thus it is error prone at a rate of 3 errors per 10,000 pages. These errors include not scanning the QR code properly or missing a page
- Sometimes machine occupancy may be an issue. For example if the scanner is integrated with the copier and not available during the day, scanning will have to be completed during off hours.
- Facilitator uploads the file including the scanned exams to the Crowdmark platform

Organize Grading Team

Convenience benefits are realized in this task since all communication and grading responsibilities can be facilitated through the online Crowdmark platform rather than an in person meeting.

Grading

The specific task of grading contributes about 50% of the total time savings that Crowdmark provides. This stage of the workflow is where Crowdmark separates itself from the traditional paper-based methodologies the most. The key contrast between Traditional vs Crowdmark grading is simply that the latter is done on a digital platform, thus modifying how graders navigate through exams, leave comments, input grades, etc. Given that the task of grading is composed of multiple subtasks, Figure 4 illustrates how much each subtask contributes to overall time saved during grading. It is interesting to note that none of the time savings result from subtask of “Assessing student work”, but rather from logistical subtasks such as those that involve paper-handling.

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Distribution of Time Savings Occuring in Grading by Subtask

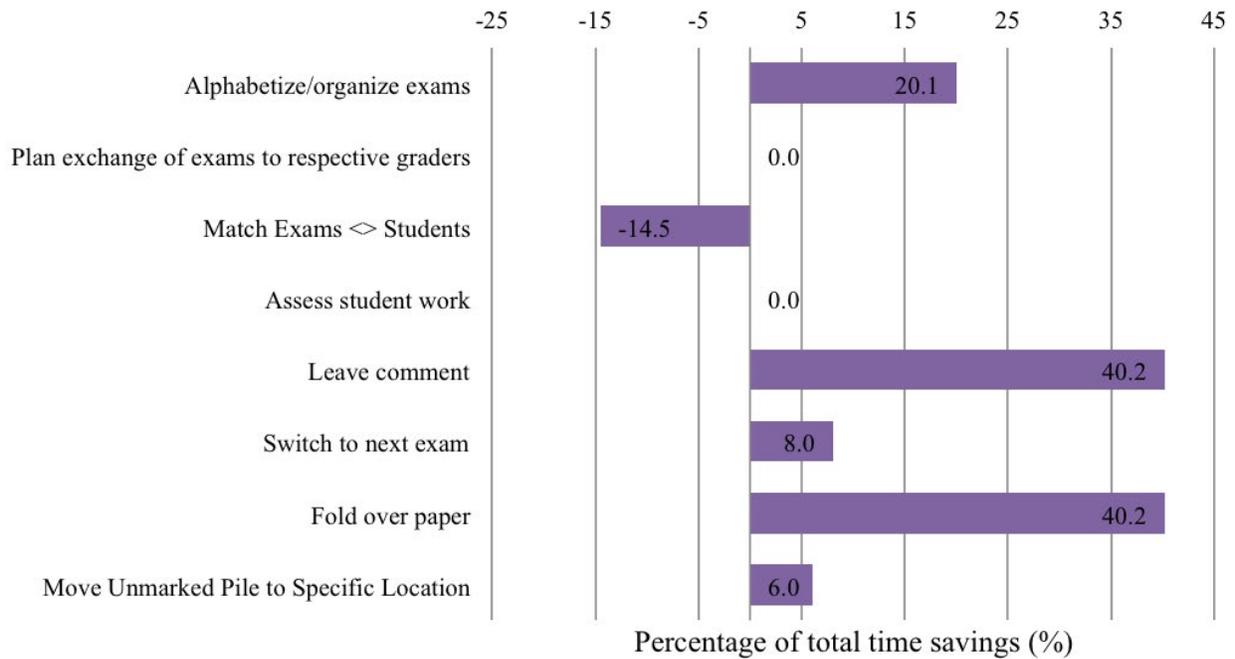


Figure 4 – Portion of time savings that Crowdmark provides during grading, organized by subtask. This figure shows how much each subtask contributes to the overall time saving in grading. This figure is representative of data for a 1000 person exam, with 10 questions per exam.

As shown in the above figure, the subtask of matching assessments reduces the time savings by about 15% given that it is unique to Crowdmark. However, the benefits that stem from this subtask includes streamlined disseminating of exams via the one click email and more structured record keeping under each student’s portfolio. Currently, the matching is done either before or after grading by matching the student metadata repository with the information on the exam cover page.

Record and Analyze Student Performance

With any kind of grading comes the responsibility of recording student performance. In the traditional paper grading process, the task of inputting individual student grades into a grade spreadsheet is completed manually by the instructor. Interestingly enough, as Figure 5 below shows, the task of recording and analyzing student performance accounts for 28-45% of the total traditional workflow time, and is heavily influenced by the number of exams written.

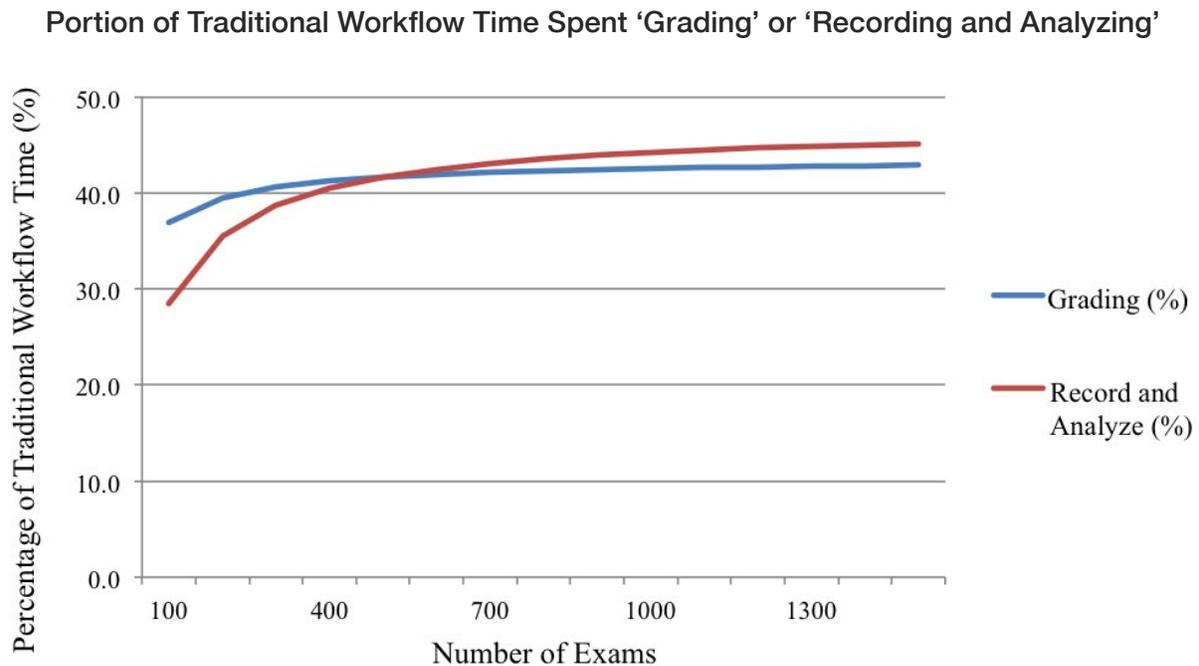


Figure 5 – Percentage of the traditional workflow time which is spent on 'grading' or 'recording and analyzing'.

Crowdmark eliminates this task altogether by automatically matching all data (including each question) to the respective student portfolio and providing analytics on the data. As a result, it is easy to see why the time saving Crowdmark provides for this task is one of the highest contributors to the total time saving in the workflow.

Return Exams to Students

In Crowdmark's workflow, the process of returning graded exams to students differs completely from the transporting and handing back of paper exams typically done in traditional methods. Relying on the digital access to exams, Crowdmark provides a streamlined workflow by allowing instructors to return the graded exams with a one-click email feature. The time required to match assessments to students is only 8% of the time that will be saved in returning exams via the one-click email.

Re-grade Requests

For all of the data modeling undertaken above, a re-grade request rate of 5% was used. To put that in perspective, for every 1000 exams, we assume 50 students will request some type of re-grade. The time saved during this task by using Crowdmark contributed about 4.2% of the total time saving in the entire workflow. Adjusting the re-grade request rate to 1% did not severely impact how much the task contributed to the savings, remaining at 3.7% of the total time savings. Clearly, this shows that the productivity benefit that Crowdmark provides for this task is present even when the re-grade request rate is smaller. The reason for this potency is that Crowdmark removes subtasks such as having to transport re-graded exams back to the students, as well as updating the grade databases.

Summary

In conclusion, Crowdmark offers a platform that provides multiple benefits to the workflow involved in exam assessments. Most notably, these benefits arise in the form of time savings, convenience gain, and the reduction of errors. It is important to note that the time spent assessing student work is not reduced through the use of Crowdmark, meaning that the quality of grading remains consistent. Rather, in creating a paper-to-cloud bridge, Crowdmark's platform eliminates many logistically-cumbersome tasks, thus reducing overall grading time to 25% of traditional grading time. Eliminating these logistically-cumbersome tasks also enhances the grading experience, by creating more flexibility regarding the location and time in which graders perform their grading.

About Crowdmark

Crowdmark is a collaborative online grading and analytics platform that helps educators evaluate student work more effectively. The platform facilitates grading of multiple assessment types, including handwritten assessments, securely in a web browser. On average, this cuts teacher grading time by 50% and assessments can be returned to students, with rich feedback, within hours. This significantly improves the student feedback loop and provides an opportunity to enrich the learning experience through analytics.



Contact Crowdmark:

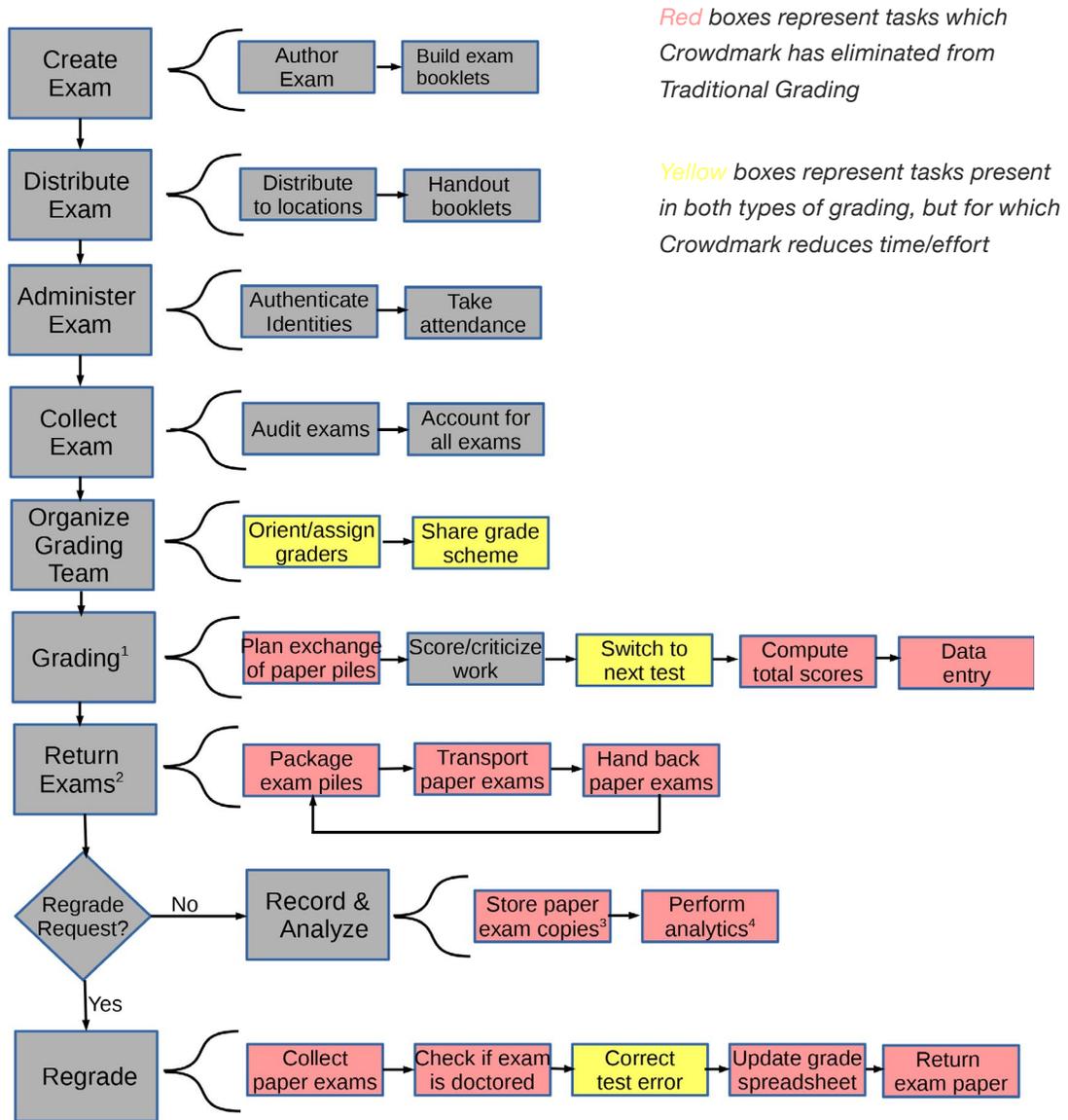
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Appendix A

Traditional Grading Process Map

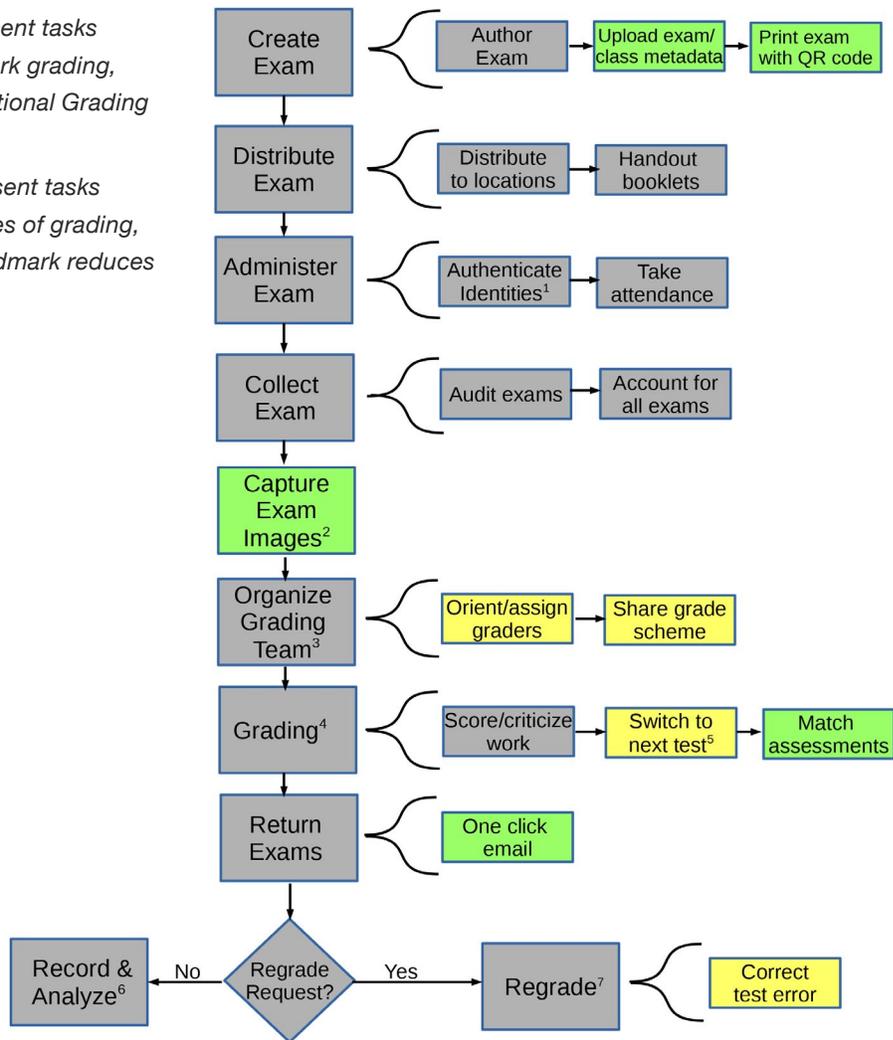


1. Grading is done sequentially, must wait for previous grader to finish pile before another grader can begin marking different questions. Also, paper copies of exams must be distributed amongst markers since there is only one copy of each exam.
2. Requires carrying marked paper exams to class room and handing them back to students individually
3. Depending on school policy, marked final exams must be stored for a specific period of time
4. All performance analytics would have to be performed manually

Crowdmark Grading Process Map

Green boxes represent tasks unique to Crowdmark grading, not present in Traditional Grading

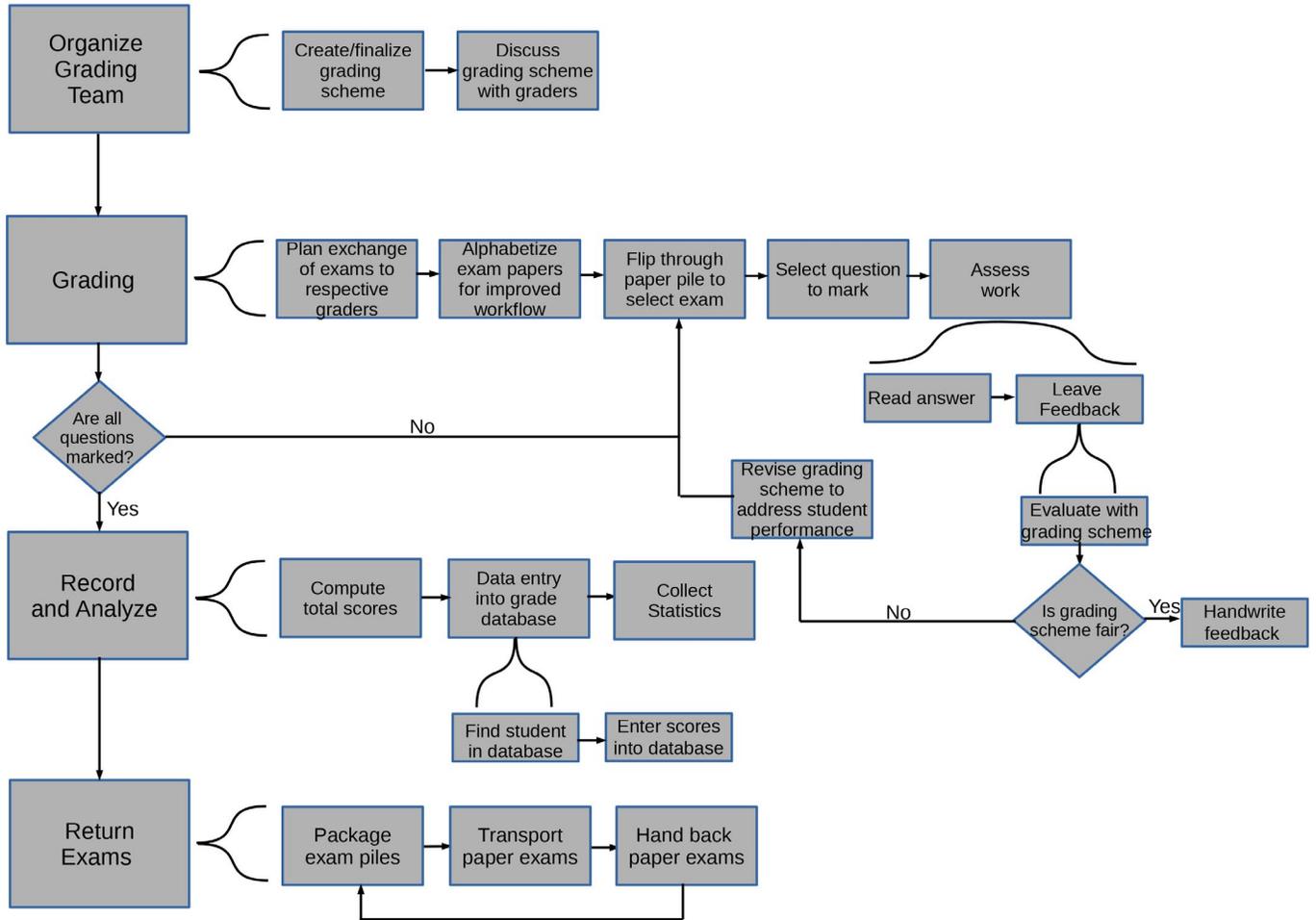
Yellow boxes represent tasks present in both types of grading, but for which Crowdmark reduces time/effort



1. Potential design addition includes matching assessment at the same time that invigilator verifies student identity
2. Outsourcing the labour of scanning to various partnerships
3. All organizing/communication is done through web using both email and the Crowdmark platform
4. All grading is done simultaneously through Crowdmark platform, tasks such as computing total score are automated
5. Switching through or waiting for marked/unmarked piles is not required, uses Crowdmark grid feature for quick exam switching
6. Storage of exams is automatic in the student's digital portfolio. Crowdmark provides data analysis features to measure performance
7. All score adjustments are automatically updated in the student's digital repository/portfolio. Easy access to student's exams

Appendix B

Traditional Grading



Crowdmark Grading

