Excellence In Services International Conference EISIC
Formerly Toulon-Verona Conference, founded in 1998

ISO 10000 INTER-AUGMENTATION IN TWO ONLINE COURSES

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Abstract

Purpose: Integrative augmentation of quality systems using ISO 10008: 2013 for electronic course delivery, ISO 10004: 2018 for measuring student satisfaction and ISO 10017: 2021 for statistical lecture control is illustrated.

Methodology: These ISO 10000 systems were applied to augment each other in an undergraduate engineering economics course with 160+ students, and in a standardized systems course offered to about 30 graduate students, taught synchronously in a Western Canadian university during the last semester of 2020. The ISO 10008 system, established for the online delivery of the two courses, supported ISO 10004 student surveys through "*Moodle*" (e.g., sub-clause 7.6) and ISO 10017 lecture monitoring with "*Google Forms*" (e.g., sub-clause 7.10).

Main findings: The ISO 10004 system was deployed to evaluate the usefulness of the lecture quality control application related to a ISO 10017 statistical technique (e.g., the percentage of "extremely", "very" or just "useful" responses increased by 9% from the "term" to the "final" undergraduate survey). In turn, ISO 10017 (e.g., sub-clause 7.1) augmented both the ISO 10008 (e.g., "initial" survey analysis posted on the course site indicated that 67% of undergraduate students denoted usefulness of showing survey results) and ISO 10004 (e.g., 57% of students in the undergraduate course agreed or strongly agreed that the "initial" and "term" survey reports were effective) systems.

Practical implications: Such inter-augmentation seems applicable, as shown, for instance, by the satisfaction with the ISO 10008 system itself (e.g., 100% of the graduate students marked "satisfied" or "very satisfied" referring to the course site), the usage of ISO 10017 techniques in lecture monitoring (e.g., during the first half of the course, the average proportion of correct answers to 25 questions following 18 lectures was 75%, not counting two that were unavailable in an example of an ISO 10008 system failure), and the student responses regarding the ISO 10004 system (e.g., only 2% disagreeing that the frequency of surveys had been adequate, with 39% expressing neutrality).

Originality / value: Examples of integrative cross-use of three ISO 10000 standards in synchronous teaching of both undergraduate and graduate online engineering courses are given.

Keywords

Customer Satisfaction; Integrated Management Systems; ISO 10004; ISO 10008; ISO 10017; Education

1. Introduction

At both previous Excellence in Services International Conferences (EISICs) in Paris (Vargas-Villarroel & Karapetrovic, 2018) and Thessaloniki (Ortiz & Karapetrovic, 2019), respectively, we talked about electronic course deliveries and the related augmentation with several ISO 10000 customer satisfaction standards, most fundamentally ISO 10008. However, there was no inclination that the next time we discuss this same integrative augmentation topic, namely two years later here in Salerno, it would have to be done for completely online courses. Nevertheless, the COVID-19 pandemic also made evident that these ISO 10000 standardized systems could be effectively and efficiently transferred for such an application. A part of that experience with two synchronously taught engineering courses in Canada from September to December 2020 can now be addressed.

The overall objective was basically to evaluate the integration of multiple augmentative systems, focused on the various combinations of these ISO 10000 systems augmenting each other, thus exhibiting "intra-augmentation", and specifically showing all potential cross-integration pairings for the three standards applied. This intra-augmentation with ISO 10008 for customer satisfaction (CS) in electronic commerce transactions, ISO 10004 for CS monitoring, and ISO 10017 for statistical techniques in quality systems, was implemented in both undergraduate and graduate engineering education, as a large compulsory engineering economics course and a medium-sized advanced standardized systems course were encompassed in the scope.

Additional methodological details for the particular intra-augmentation are presented first, followed by an illustration of the related examples broken down into two parts, namely regarding different ISO 10008 – ISO 10004 – ISO 10017 combinations, on the one hand, and the application of Statistical Process Control (SPC) and the corresponding student surveys, on the other. Finally, conclusions also relate to further related research activities being conducted simultaneously with this EISIC in Salerno.

2. Methodology

Three standards, developed by the Sub-Committee SC3 of the International Organization for Standardization's (ISO) Technical Committee (TC) 176, namely ISO 10008: 2013, ISO 10004: 2018, and ISO 10017: 2021, were used for mutual augmentation. The first two of these belong to the CS subset of five such ISO/TC176/SC3 standards, while the latter one was originally published as a "Technical Report" some two decades ago, and consequently is not an "augmenting" standard itself. Nevertheless, the processes illustrated in ISO 10017 (e.g., for SPC) were applied with mostly informational resources (e.g., web forms and spreadsheet software) to achieve both teaching quality and augmentative integration with ISO 10008 – related goals, and hence could be considered to have formed an augmentative subsystem therein. In terms of their present status, ISO 10008 is being revised (but the still-current 2013 version was used in the implementation), the revised version of ISO 10017 was published only two months ago (and the related clauses shown in the application are from this version), while ISO 10004 is in its third, three-years old, edition.

This intra-augmentation is shown for an undergraduate engineering economics course that more than 160 students attended, and a graduate course on standardized systems course with 30 students. Both courses were offered online, with synchronously-conducted lectures throughout the last semester of 2020. The courses were taught by a single professor. The university's location is in Western Canada.

The foundation for the cross-integration was established through an ISO 10008 system (e.g., see previous related EISIC papers, such as Vargas-Villarroel & Karapetrovic, 2018, and Ortiz & Karapetrovic, 2019). This system then supported ISO 10004 student surveys through

"*Moodle*" (e.g., with ISO 10004: 2018, sub-clause 7.6 guiding the administration of the "term" and "final" surveys in the graduate course) and ISO 10017 lecture monitoring with "*Google Forms*" (where, e.g., ISO 10017: 2021, sub-clause 7.10 – mentioned SPC was applied to the results of student answers to questionnaires based on Angelo and Cross' "*Background Knowledge Probes*" (Angelo and Cross, 1993), which were administered before and after every lecture of the undergraduate course, see, for instance, Karapetrovic & Rajamani, 1998, Grygoryev & Karapetrovic, 2005, and Agrawal & Khan, 2008).

3. Results: ISO 10004 Student Surveys

Selected findings from two surveys, conducted close to the middle of the course ("term") and towards the end ("final"), are now shown for both courses from the perspective of various cross-system augmentations. The response rates were 6% and 33% for the "term" and "final" survey, respectively, in the undergraduate course, while the corresponding rate in the graduate course fell from 17% to 13%. The survey questions related to the usefulness and effectiveness of system components on a 1-5 scale (1/2/3/4/5 indicating "not/barely/-/very/extremely useful" for the former and "strongly dis/dis/neutral/-/strongly agree" with specific related statements for the latter), while the corresponding results here are illustrated with the response means.

For the augmentation from ISO 10004 to ISO 10008, namely where the ISO 10004 CS monitoring subsystem supports the ISO 10008 system for the overall course delivery (e.g., see 8.3 of ISO 10008: 2013, and Vargas-Villarroel & Karapetrovic, 2018), the undergraduate students could rate the usefulness of the information resources in the form of two types of online tutorial videos, specifically where "examples" of problem solutions and "derivations" of formulae used in the course were shown, respectively, as well as interactive "tutorial" files. They indicated that the first type of videos, i.e., "examples", was highly useful in both the term (mean of 4.50) and final (mean of 4.57) surveys, at evidently almost the same level in the mid- and end-term CS monitoring. However, that was not the case for the second type, since the mean for the usefulness of "video derivations", the knowledge of which was not tested and was practically only needed in the first half of the course, not only fell from 3.6 to 3.2, but was also not as high in either survey. The tutorial files were rated in the middle, i.e., with the mean decreasing from 4.1 to 3.8. On the other hand, graduate students thought that "video tutorials" were also significantly useful, with the mean holding steady from 4.80 to 4.75. In addition, comments were provided regarding the ISO 10008 system's application (e.g., see 7.1.5 of ISO 2018: 2013), for instance: "*I really enjoyed how the [course site] page was laid out. (…) It was not cluttered.*", which was then used to reinforce the further streamlining of course site sections and even their corresponding titles for the next offering of the course.

In the reverse sense of this ISO 10004-ISO 10008 intra-augmentation, the ISO 10004 surveys were administered online through an ISO 10008-guided course site (e.g., see ISO 10004: 2018, sub-clause 5.2, paragraphs 2-5, as well as sub-clause 6.4 and section 7.3.4). Both undergraduate and graduate students agreed that the frequency of these surveys was adequate (e.g., see sub-clause 6.2 of ISO 10004: 2018), with the respective means of 3.77 and 4.00 obtained in the final survey. Related comments were also sent, such as: "*It would be better if we receive email notification of all changes made by the Professor or TA on [the course site]*…".

The ISO 10004 CS monitoring subsystem also augmented ISO 10017 SPC, where the term survey showed the means of 3.00 and 4.60 for the usefulness of the "before and after lecture questionnaires" in the undergraduate and graduate course, respectively, while the related final survey means were 3.13 and 3.75. In the opposite augmentation sense, ISO 10004-guided survey reports were provided on the course site, using ISO 10017:2021 statistical methods from sub-clause 10.1. These reports were deemed useful (e.g., with the means of 3.22 for the initial

survey report usefulness and 3.72 for the effectiveness of such initial and term reports in the undergraduate course).

Finally, with respect to the cross use of ISO 10017 and ISO 10008, the establishment of ISO 10017 questionnaires through "*Google Forms*" followed IS0 10008, while, for instance, in the final graduate course survey, students indicated high agreement (mean=4.25) with the statement that the course site met their needs, which is also related to ISO 10004: 2018 (e.g., see the respective sub-clause 5.1).

4. Results: ISO 10017 Lectures SPC

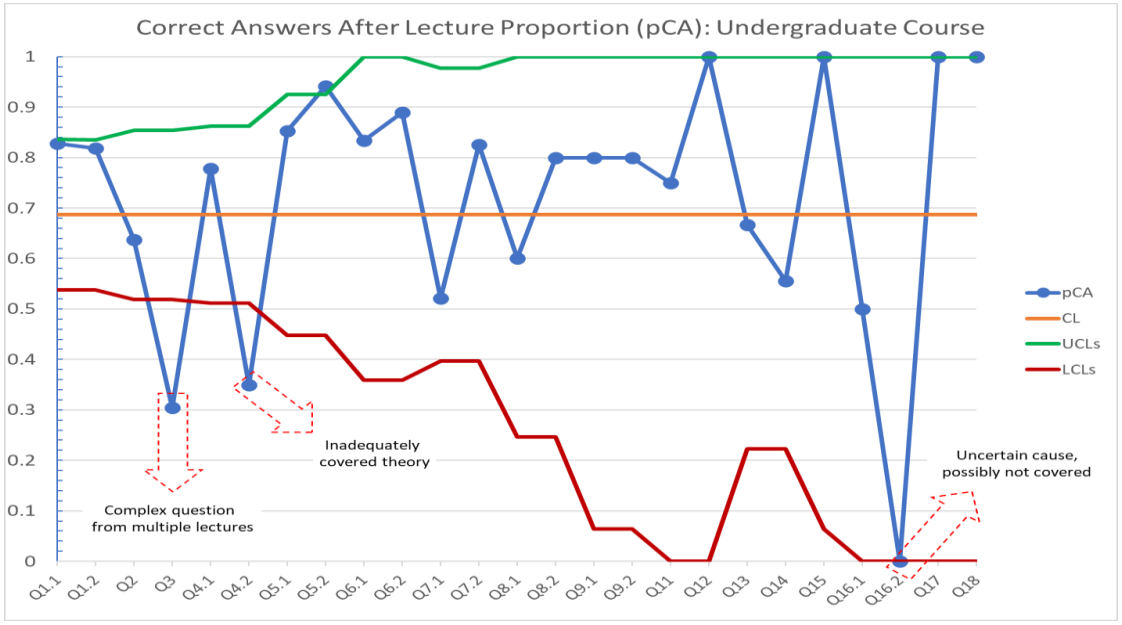
In the undergraduate course, SPC monitoring (clause 7.10 of ISO 10017: 2021) was applied before and after practically every non-exam class, and hence there could be a total of 36 available lectures, with one to, more commonly, two "*Google Form*" questions asked per instance. These questions are labelled as "X.Y" in instances where there is more than one question per lecture, with "X" and "Y" indicating the ordinal numbers of the lecture and the question in each lecture, respectively (e.g., "Q16.2" was the second question in the sixteenth lecture). The number of students participating started with a high of 87 and 88 in the first lecture on questions Q1.1 and Q1.2, respectively, but generally declined thereafter, e.g., to 63 in the fourth lecture and 23 in the seventh.

The links to questions were available in a sub-section of the course site, where other "learning tools" were also provided within the same section. Using the ISO 10008 system, the professor would usually show the link to the "before lecture" form prior to the class, then disable the response feature after a few minutes, and open the link to the "after lecture" following class completion. However, demonstrating two instances of an ISO 10008 system failure (e.g., ISO 10008: 2013 guidelines from sub-section 6.1.3.1, second paragraph, third bullet were specifically not met, while the actions suggested in sub-section 6.1.3.2, fourth paragraph could have been more effectively implemented to obtain immediate student feedback), there was no availability to answer questions after lectures 10 and 18. Namely, the related questions (two for the former and one for the latter lecture) had been prepared, but the questionnaires meant for after the lecture were not shown on the course site to students, as the procedure was to reveal them only after the class had ended. The related "*correction*" (section 6.3.3. of ISO 10008: 2013) was to still provide the related report on the course site, but following sub-clauses 8.2 for "*evaluation*" and 8.5 for "*corrective action*", the site will be updated to automatically show and hide the links at certain times at the beginning and end of lectures in the next offering of the course section 6.1.2 of ISO 10008: 2013).

For the undergraduate course, a "pCA" chart exhibiting the proportion (p) of students with correct (answers) after (CA) the lecture was drafted (Figure 1). Clause 10 of ISO 7870-2: 2013 was used for calculations of the Upper and Lower Control Limits (UCL and LCL), with variable sample size (for instance, see Karapetrovic & Rajamani, 1998), as the number of students answering the related "*Google Form*" changed from lecture to lecture, e.g., 34 to 18 from lecture #5 to #6, and even from question to question in the same lecture, e.g., as seen above for lecture #1. Guidance from the same clause 10 of ISO 7870-2: 2013 was applied for adjusting the limits (e.g., to "0" for the LCL in questions Q11-12 and Q16-Q18).

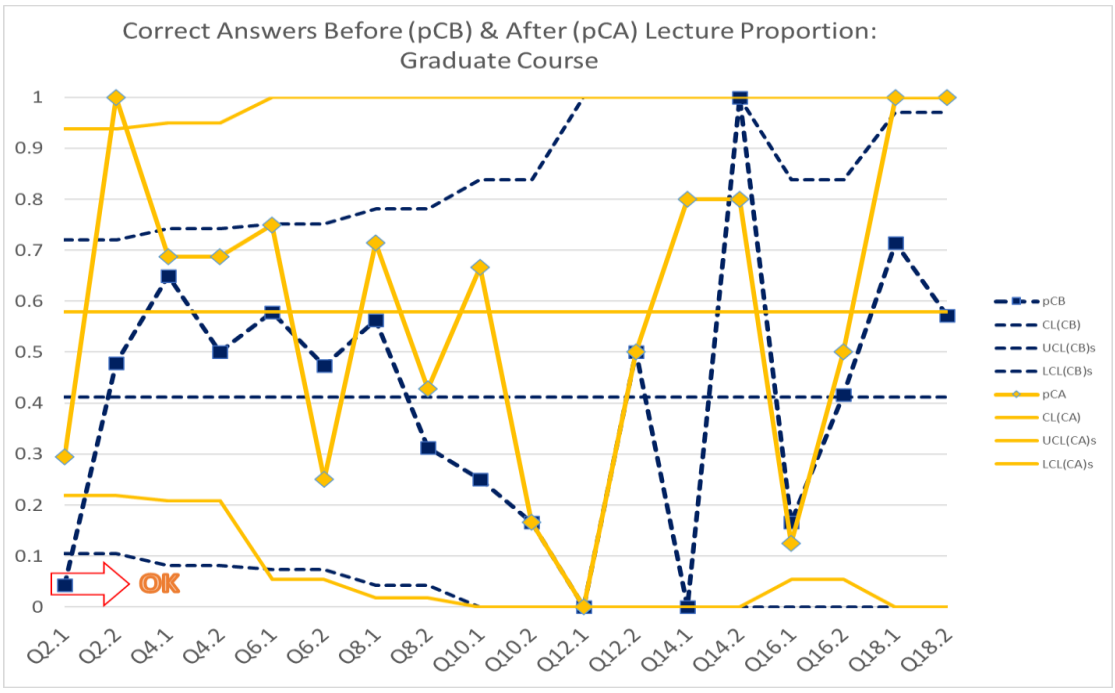
The Central Line (CL) was 68.7%. This was slightly lower than the process was used in the same course offered to a similar number of students immediately prior to the pandemic. However, the questions had not been administered in every lecture and the course was completely in person. As can be seen in Figure 1, there were three points outside of control, specifically Q3, Q4.1 and Q16.2, with potential causes mentioned in the figure.

Figure 1: pCA chart for a 2020 undergraduate online course



Conversely to the undergraduate course, where the Google forms were administered in practically every non-testing lecture, the questionnaires were used every second lecture in the graduate course. Figure 2 shows the related pCA and pCB charts ("Correct Before" for the latter). Due to the ethics requirements mandating anonymity of students in this research (e.g., thus making certain activities in section 7.2.3 of ISO 10008: 2013, such as bullets two to five, unnecessary, as there was no "personal information" collected) and separate forms used in each lecture, the integrated "Incorrect Before – Correct After" statistic applied during in-person classes (e.g., see Grygoryev & Karapetrovic, 2005) was not used.

Figure 2: pCB and pCA charts for a 2020 graduate online course



For consistency with the presented data from the undergraduate course, only the first half of the course (i.e., 18/36 lectures) is covered with Figure 2, hence there are 18 Qs here instead of 25 in Figure 1. In all but one lecture, more students answered the questions before the lecture than after (as, e.g., time was left during the class before, but not always after).

The students in the undergraduate course perceived these questionnaires as "useful", with the mean on the related survey question slightly increasing from the term (3.0) to the final (3.13). survey, as can be seen in the previous section. The change in the mean as observed in the graduate course was the opposite (decreasing from 4.6 to 3.75), thus evidently graduate students seemed to have viewed the usefulness of this application to a much higher degree (between "very" and "extremely" useful) the first time, as opposed to close to "very useful" at the end.

5. Conclusions

Intra-augmentation of standardized quality management systems, focused on ISO 10000 series generally and customer satisfaction specifically, was demonstrated through examples from an application in two online engineering courses from the last semester of 2020 and with ISO 10008, ISO 10004 and ISO 10017. Such integrative augmentation is not only possible, but also shown to be useful, at least when implemented in such an engineering education setting. Nevertheless, the application was limited to online courses only, taught by the same professor. Since in-person classes are starting to be taught again and there has been plenty of integrative augmentation and statistical process control - related research in such courses (e.g., see Fernandez-Ruiz et al, 2017, and Karapetrovic & Rajamani, 1998), future work can contain comparisons with earlier or currently taught in person and online courses, as well as with augmented applications of the already-used standards (e.g., the four mentioned here or the ones discussed in Fernandez-Ruiz et al., 2017, for education, or see Astleitner & Karapetrovic, 2017). This is already in progress, as intra-augmentation is being applied in online courses starting this September, with the first lectures taught from the very EISIC 2021 location.

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