

Chapter 6

Integrating Student E-Portfolio into a Statistics Course: A Case Study

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Abstract The element of e-Portfolio was integrated into a general education (GE) course in elementary statistics consisting of mainly first year undergraduate students from different disciplines. While building an appropriate statistical sense in daily life scenarios was a key learning outcome, there was a need for a platform for constant reflections throughout the course. Introduced as a continuous assessment component leading to the end-of-semester group presentation, the student e-Portfolio provided not only such a platform, but also a foundation for further interactions among students. Moreover, the e-Portfolio played a major role in linking up other existing components of the course, while feedback suggested that such integration was generally valued by the students and the overall effectiveness in learning was enhanced. However, students also demonstrated mixed attitudes toward using e-Portfolios, with technical difficulties possibly a major obstacle. Both benefits and drawbacks of the implementation of the e-Portfolio are discussed and directions for possible improvements and further investigation are also explored.

Keywords E-portfolios · Mathematics education · Peer learning

Introduction

As a part of the major reform of the secondary and postsecondary educational systems of Hong Kong (the 3 + 3 + 4 reform), the undergraduate programs in Hong Kong switched from 3-year to 4-year curricula in 2012. Among many changes that came along with the overhaul of the academic structure, HKBU introduced the General Education (GE) Program to enhance Whole Person Education (WPE). Particularly, one important Program Intended Learning Outcome

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(PILO) of the GE Program focuses on the application of appropriate mathematical reasoning to address everyday life problems.

The role of context in the teaching and learning of mathematics has been studied by many mathematics educators (see Boaler 1993 for example). Different social or cultural contexts significantly affect the understanding of mathematical concepts (see Oughton 2013 and Bishop 1988 for discussions on social and cultural contexts respectively), while very often a clear linkage to the real world provokes mathematical thinking (see Gibney 2014 for example). Thus the GE courses in numeracy were designed to offer students insights and raise students' awareness in the use of quantitative methods and data in addressing different practical issues. Such courses cover aspects of numeracy including but not limited to probability, statistics, and information technology numeracy, highlighting their applications in daily life.

After the first semester of the new curriculum, four GE courses in numeracy were selected to assess the impact on students in terms of the achievement of the aforementioned PILO. Results showed that while students performed well in most elements of quantitative reasoning, the aspect of communication, which is defined as "expressing quantitative evidence in support of the argument or purpose of the work" in the AACU rubric used in the assessment, seemed to be a relative weakness (To 2013).

Communication, in a broader sense, is not only seen in mathematics education as a demonstration of the level of proficiency but also an integral part of the process of achieving deep understanding (Stahl 2009). Through studying young children learning mathematics, Sfard argued that mathematical cognition does not only come from an individual rationalist process but also from a discursive social one (Sfard 2008). She suggested that mathematical objects such as formulas are products of discursive constructions constantly adding to the objects' complexity, and deconstructions of such collective processes would be beneficial to the understanding of the objects themselves (Sfard 2008). Other studies also support that collective effort has a major impact in the process of establishing mathematical sense and acquiring mathematical problem solving skills (Martin et al. 2006; Powell 2006).

As a means of communication of knowledge and reflective comments among students and teachers, e-Portfolio has been used in many different disciplines (see Fitch et al. 2008 and Lorenzo and Ittleson 2005 for example). While the use of e-Portfolios as an assessment is still a relatively less common practice in the field of mathematics education, it is not entirely new to the discipline and has shown potential. Bairral and dos Santos used e-Portfolio to extend the scope of mathematical learning to cover not just skill-based aspects but also communication in the context of training for preservice mathematics teachers (Bairral and dos Santos 2012). In a more recent large-scale implementation of the e-Portfolio assessment of the college-wide learning outcome of quantitative literacy at Salt Lake Community College, Hubert and Lewis concluded that e-Portfolios lead to an assessment that is supported by authentic evidence (Hubert and Lewis 2014).

Implementation

Overall Structure

We integrated the use of student e-Portfolios into the GE course “Speaking of Statistics” in the first semester (September to December) of 2014–15 (pilot implementation) and in 2015–16 (second implementation). The course has four Course Intended Learning Outcomes (CILOs), while three of them are directly related to the daily life or daily situations:

1. Explain basic statistical terms and concepts behind valid statistical arguments
2. Interpret quantitative data in daily life from the appropriate statistical point of views
3. Identify and demonstrate statistical methods used in daily life examples
4. Evaluate statistical claims in commercial advertisements or daily situations for their truthfulness.

E-Portfolio element was incorporated into the course as a new teaching and learning activity to mainly address CILO3 and CILO4. Prior to the incorporation, activities such as written classwork and assignments were together addressing almost all CILOs without a very clear continual focal point, at times making reflection more challenging. With e-Portfolios introduced alongside the existing written assignments, it was hoped the e-Portfolios could help students keep track on the buildup of their statistical sense in daily life, while other written assignments could address on other important aspects such as computations, basic statistical terms and concepts, giving a clearer structure to the organization of the teaching and learning activities.

Before the introduction of e-Portfolio, detailed instructions for the group presentation component were usually given to the students in the last month or so of the semester, while some students tended to put in significant effort only days before their scheduled date of presentation. It was also observed that the group presentation component itself was considered by some students as more of an isolated component of the course that demands attention and effort only in the last part of the semester. The selection of presentation materials was therefore sometimes done without thorough discussion and consideration among group members as it was not uncommon for students to settle with the first feasible choice they came across, especially with a relatively tight schedule. On the other hand, the level of contribution of different members of the group in such selection process could also vary greatly. It was possible that some students, intentionally or not, did not actually contribute any alternative choices of materials for presentation. Such uneven contributions among different group members might also be seen in the subsequent preparation of the presentation in some cases. As a common group dynamics problem encountered in many occasions involving group work, freeriding, which is an extreme form of uneven contributions within a group with potential hindrances to team performance and learning process, has been studied extensively

in the literature, not only in the field of education but also in other disciplines such as business (see Albanese and Van Fleet 1985 and Joyce 1999 for example). The freeriding phenomenon could be explained economically (Albanese and Van Fleet 1985). Practical solutions have been suggested, with the level of delegation of power to students being one of the key choices to make for teachers (see Joyce 1999 for example) (Fig. 6.1).

In light of the above observations, e-Portfolio was introduced to the course as an extension of the end-of-semester group presentation. It took the form of an individual online journal with four blog entries. Each of the first three entries had a theme and consisted of tasks that the students had to complete according to some guiding instructions. After finishing the first three entries, students formed groups of two to five, and each group prepared a 10-min presentation on selected materials from members' individual e-Portfolios. Such an arrangement was meant to promote the exchange of ideas via e-Portfolios among different students, and to ensure baseline contribution of group members in the preparation process, partially addressing the freeriding problem. Such exchange of ideas was expected to be facilitated by the accessibility of the online nature of the e-Portfolio.

In the final entry of the individual e-Portfolio, students were asked to reflect on aspects such as challenges met in the preparation process, their own performances and possible improvements. This entry served as a guided overall reflection on both the group presentation and the course as a whole. It was designed to extend the learning process beyond the end of the group presentation. Figure 6.2 shows the structure of the implementation.

A pilot implementation was completed in the first semester of 2014–15. Students' feedback was collected before the end of the teaching weeks. Table 6.1 shows the distribution of the results (questionnaire adopted from Shroff et al. 2013).

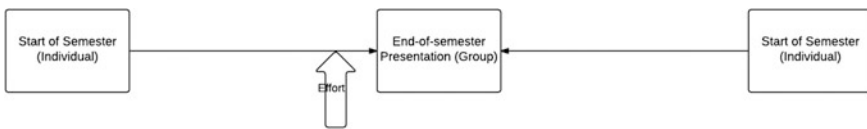


Fig. 6.1 Before implementation: last-minute effort (To 2015)

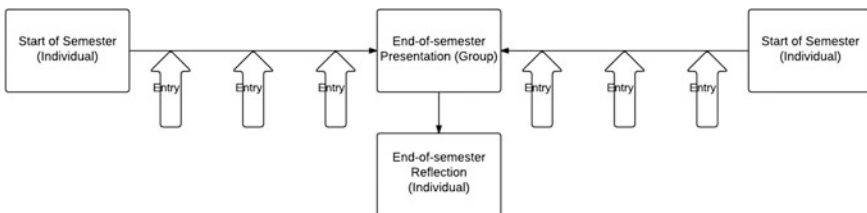


Fig. 6.2 Implementation: constant effort and reflection (To 2015)

Table 6.1 Students' feedback on pilot implementation

#	Question	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)	Mean
2	I acquired useful skills in creating my e-Portfolio	23.53	55.88	14.71	2.94	2.94	2.06
3	The process of creating my e-Portfolio helped me to take responsibility for my own learning	32.35	41.18	17.65	2.94	2.94	2.00
5	Overall, I valued the integration of the e-Portfolio into this course	17.65	50.00	29.41	0.00	2.94	2.21
6	Overall, I am satisfied with the way my learning is assessed using the e-Portfolio in this course	20.59	44.12	20.59	8.82	5.88	2.35
10	I have a generally favorable attitude toward using the e-Portfolio	11.76	52.94	20.59	14.71	0.00	2.38
11	Using the e-Portfolio enhanced my effectiveness in learning	17.65	50.00	23.53	5.88	2.94	2.26

The structure of the second implementation in 2015–16 was very similar to that of the pilot implementation of the e-Portfolio component in 2014–15, with minor adjustments made based on feedback obtained in the pilot run:

- Entry 1 (Early October): The first entry of the e-Portfolio in the pilot implementation focused on misleading statistical presentations. Each student was asked to identify two items (images or videos) with some misleading statistical elements. The students described the items and commented on the abuse or misuse of statistics therein. During the pilot implementation, students occasionally reported confusion regarding the instructions given due to the lack of restrictions on the nature of the multimedia to be used for the task. In response to that, in the second implementation, this entry's focus was then further restricted to the use of numbers/statistics in commercials. Instead of any multimedia example, each student was asked to find two examples of a print advertisement in which numbers/statistics were used. Moreover, students were also given more guiding questions, as they were prompted to describe the roles of such



Tutorial School - Geography Tutor

When and where did I see it?

This picture was taken by me on the bus in Sham Shui Po on 27 Sept 2015

How were numbers/Statistics used in this commercial?

The statistics were used to show how popular the tutor is by stating he has the largest number of students and students who getting 5**/5*/5.

On a 1/2/3/4/5 scale (5 being most convincing), how convincing do you find this commercial? Why?

3. Firstly, there are three sentences with a relatively small font size of words showing the evidence which supports its claim of statistics. Besides, while i believe that both two claims are true, it does not mean that the tutor has the highest percentage of having 5**/5*/5 students. This is because he

Fig. 6.3 Student’s work: entry 1

numbers/statistics in the advertisements, as well as to explicitly rate their level of convincingness in a 5-point scale (Fig. 6.3).

- Entry 2 (Late October): The theme of the entry for the second implementation, which consisted of two tasks, was the use of averages in news. In the first task, students were given two articles related to the two different concepts of poverty lines, namely the absolute poverty line set by the World Bank and the relative poverty line, which is defined to be half of the median of the household income by the Hong Kong Government. They then answered simple questions related to the articles and commented on the suitability of the two poverty lines for the Hong Kong society. In the second task, each student was asked to identify another news article involving the use of averages from a local news agency, and to rate both the importance and the suitability of such use of averages in the article. This entry in the second implementation was different from the one in the pilot run, which simply required each student to find and comment on two local news articles, one involving the use of mean and one involving the use of

median, without much limitations on the nature of the news. The amendments made to the entry were due to the observation that students tended to feel more on a familiar ground with more concrete guidelines on the choice of materials, taking into account that the task involved choosing from a relatively much wider range of materials compared with Entry 1. The poverty-lines-related articles provided in the first task offered students insights and a concrete example for their search of their own materials for the second task.

- Entry 3 (Mid November): The third entry focused on questionnaire design. In the pilot implementation, each student was asked to identify a news article reporting on a questionnaire survey done by a local organization. The student then had to find the actual questionnaire and identify two mistakes in its design. In the revised version of the entry, an extra part, with a news article and a questionnaire provided as a starting point, was introduced. This extra part of the revised entry involved a given questionnaire designed by the Hong Kong Public Opinion Poll for a survey chartered by a local political party and a related news article. Students answered simple questions related to the survey which highlighted some standard sampling procedures and standard survey practices such as random selections of interviewees within selected households. The second part of the entry required more active input from students. To make instructions more specific than the ones in the pilot implementation, each student was asked to identify one questionnaire designed by a local political party, instead of any survey agencies, with at least one element of improper design. The student then commented on one such problematic aspect of the questionnaire and rated the overall quality of the questionnaire design in a 5-point scale.
- Group Presentation (Late November): Each group consisted of two to five students and was required to do a 10-min presentation with optional Q&A. In the pilot run, each group could either choose a questionnaire collected for Entry 3 among all its members or look for another questionnaire for the presentation, in which they had to provide a thorough critical analysis on the questionnaire design. However, with the option of using materials not from the e-Portfolios, there was less incentive for students to share and read each other's work, potentially undermining the benefit of peer learning. In the second implementation, such an option was no longer available, and each group had to choose a questionnaire collected for Entry 3 to carry out a thorough critical analysis. While Entry 3 only required indication of one problematic aspect of the questionnaire, some collective inputs were expected for completion of this part. Unlike in the pilot run, the presentation in the second implementation had an extra part, in which the groups were required to choose, from all advertisements collected for Entry 1 by the members, two commercials to present. While each group could base the presentation on the contributors' e-Portfolio entries, input from all members, instead of mere repetitions of the content of the contributors' e-Portfolios, was expected.
- Entry 4 (Early December): The fourth and final entry for the pilot run was a reflection on the group presentation, while the revised version included also a reflection on the course as a whole. Individually each student reflected on the problems the group encountered during the preparation process. Students were

I would like to rate 1 to the level of difficulty of the topic-selection process of our group. We are very satisfied with the materials we have chosen. We looked through everyone's work and discussed about how many problems we could find in the ads and questionnaires we had. We selected the ads in which we could find at least two problems that we had learned, making sure that we could have enough things to present. So finally we chose 2 of them which covered different kinds of problems. Just like the PPT slide below, we made it possible to present more area in limited choice. However, when we wanted to elaborate a lot on we got some problem. Because we thought that some of the problems we came up were too minor to discuss. And after heard other groups' presentation, we found that many group ignore the problem of "the scale of presenting the numbers" So we finally got what were worth to be disgusted.



Fig. 6.4 Student's work: entry 4

asked to state if they had considered any alternative choices, and elaborated on the rationale behind the final decision and whether or not they were satisfied with the choice. They were also guided to reflect on the impact, if any, of reading the e-Portfolios of other group members. Strengths and weaknesses of the group's performance in the presentation were also discussed. For the reflections on the course itself, students stated things they learned from the course and what they thought would be interesting to investigate more (Fig. 6.4).

Assessment

Assessment for the pilot run was on an entry-by-entry basis, using a slightly different rubric for different entries and with each entry assessed separately after its deadline. However, such a practice seemed to work against the continual nature of the e-Portfolio as an organic and coherent collection of artifacts and reflections. Completed entries tended to be static after the assessments, and the e-Portfolios generally looked more disjointed, potentially with entries scattered across different pages in a less organized manner. To address such problems, the assessment of the e-Portfolios in the second implementation came in two parts. Throughout the semester, comments were given by the instructor using the blog's online commenting function. Students were free to make changes, taking into account of the instructor's and other students' feedback, before the end of the semester and the deadline of the final entry of the entire e-Portfolio. The complete e-Portfolio was then formally assessed according to the rubric consisting of four main categories:

- Information: accuracy and clear indication of sources
- Subject knowledge: proper statistical view point
- Organization: clarity, coherence and logic of presentation
- Language and communication: effective delivery of ideas and use of multimedia.

Choice of Platform and Technical Support

Weebly, with its relatively intuitive drag-and-drop interface, was selected as the platform for the implementations. A briefing session of 30 min to 1 h on the use of the site-building tool was given to the student. The session was conducted in a standard lecture room setting without desktop computers provided. Students mainly used their own electronic devices with access to the internet for hands-on tasks during the briefing session, in which accounts were set up and web addresses were collected on the spot.

Results and Discussions

Students' Perception and Self-assessment

A questionnaire survey (adopted from Shroff et al. 2013) for the second implementation was conducted near the end of the first semester. The questionnaire consists of two parts, with the first part focusing on students' feedback on various aspects of the implementation and the second part on the general background of students, including their level of expertise related to the use of e-Portfolio. Table 6.2 shows the result of Part I.

The numbers suggest mixed to positive attitudes toward using e-Portfolios from students. Students were able to engage with the e-Portfolio with a sense of control while reflecting upon their achievement (Q7, Q8 and Q9). However, opinions were more diverse in some cases. While close to half of the students believed that the e-Portfolio enhanced effectiveness in learning, over a quarter of the class disagree. Students' opinions on whether useful skills were acquired and whether creating the e-Portfolio helped them to take responsibility for their learning were similarly split, with around 60% of the students agreeing and over 20% disagreeing (Q2 and Q3). It is also an interesting point to note that students of the pilot implementation offered a much more positive self-assessment in these two aspects, with over 70% acknowledging positive impact. A possible explanation to the discrepancy in the assessment of taking responsibility of learning could be the more explicit and restrictive guidelines provided in the second implementation. Other factors contributing to the generally less positive feedback from students in the second implementation remain to be identified.

Table 6.2 Students' feedback on second implementation

#	Question	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)	Mean
1	Overall, I found constructing the e-Portfolio valuable to this course	8.51	48.94	34.04	6.38	2.13	2.45
2	I acquired useful skills in creating my e-Portfolio	12.77	51.06	14.89	19.15	2.13	2.47
3	The process of creating my e-Portfolio helped me to take responsibility for my own learning	23.40	36.17	19.15	21.28	0.00	2.38
4	Showcasing electronic media (i.e., text-based, graphic, or multimedia elements) in my e-Portfolio allowed me to demonstrate a more meaningful understanding of my course	14.89	46.81	23.40	10.64	4.26	2.43
5	Overall, I valued the integration of the e-Portfolio into this course	12.77	51.06	25.53	8.51	2.13	2.36
6	Overall, I am satisfied with the way my learning is assessed using the e-Portfolio in this course	17.02	46.81	31.91	2.13	2.13	2.26
7	I was able to engage with the e-Portfolio interface in a worthwhile manner	19.15	53.19	17.02	8.51	2.13	2.21
8	I could exercise choice in how I customized my e-Portfolio entries	17.02	42.55	31.91	6.38	2.13	2.34
9	Constructing the e-Portfolio helped me to reflect upon my achievement	14.89	46.81	27.66	8.51	2.13	2.36

(continued)

Table 6.2 (continued)

#	Question	Strongly agree (%)	Agree (%)	Neither agree nor disagree (%)	Disagree (%)	Strongly disagree (%)	Mean
10	I have a generally favorable attitude toward using the e-Portfolio	29.79	27.66	25.53	14.89	2.13	2.32
11	Using the e-Portfolio enhanced my effectiveness in learning	17.02	31.91	25.53	23.40	2.13	2.62

Other comments from students also came with similar diversity, and such diversity is in line with the instructor’s observation throughout the semester. Though described as an “attractive” and “useful” way to show the learning process and generally accepted, if not valued, some students had reservations about the necessity of the implementation. Many saw the e-Portfolio as only a new form of written assignment without appreciating the benefits generally recognized by educators. However, it might be worth to note that, such a response is indeed typical whenever a new form of assessment is introduced in a course. On the other hand, the rationale of linking the presentation with the e-Portfolio was also questioned, though over 60% of the students valued the overall integration of e-Portfolio into the course (Q5).

In their reflections (Entry 4) on the preparation of the presentation, especially the material selection process, most students reported contributions of most group members in the form of sharing of group members’ own portfolios. This demonstrates the effectiveness of utilizing e-Portfolios to ensure baseline contributions in a group assessment, though the overall contributions of different members in a group could still vary, as observed by the instructor in the presentations.

Usage and Performance

Over half of the students reported a frequency of reviewing, interacting with or adding to the e-Portfolio at least a few times a month. After working with the e-Portfolios, close to 80% of the students considered themselves to be moderately experienced in using e-Portfolios. In terms of consistency with other assessment components, the students’ scores of the e-Portfolio component have a weak to moderate positive correlation (with a correlation coefficient of 0.39) with their total scores of the written test components. This may partially be explained by the different emphasis of the assessment components. Written test components focus mostly on subject knowledge and its applications, with communications and

organization as secondary concerns, while the e-Portfolio component emphasizes not only on subject matter but also the presentation of materials in a coherent and logical manner as well as effective communication. Students were also generally satisfied with the overall assessment (Q6).

Background of Students

Students of the course had almost no prior experience with e-Portfolio, with over 90% reporting such absence of experience before taking the class. Such a phenomenon was expected as the course was intended mainly for first year students, and this was indeed the first semester of the 4-year curriculum for over half of the class.

Limitations and Recommendations

Technical issues were one of the major obstacles of the implementation, which is not a surprise given the overall lack of prior experience with e-Portfolio, though it should be noted that some technical issues were platform specific and might have little to do with general prior experience. Sessions in a computer lab are recommended, though some more IT-literate students were actually able to proceed without such arrangements. One fairly common complaint throughout the semester was that the supposedly published content did not show up in the e-Portfolio. Most of such cases were due to a slightly complicated publishing procedure of the Weebly blogs that could give a false impression that the content was successfully published. However, such technical issues notwithstanding, students generally had a certain sense of control over the choices in how the e-Portfolio entries were customized (Q8). Another complaint was that Weebly frequently sent out promotional materials to the students, causing some nuisance. While this might be a platform-specific problem, this could be a point for caution if any free third-party portfolio-building service is to be chosen.

Extra workload associated with the introduction of e-Portfolio was also one of the major concerns for both teaching staff and students. To accommodate such an increase in effort demanded and maintain a similar level of overall workload, some other written assessments were shortened and combined. Such a practice of replacing some existing assessment components with e-Portfolios is recommended and it might also be a good practice to inform the students about such changes to manage students' expectation on workload.

Though the introduction of e-Portfolios provided students with more opportunities to formulate their ideas and communicate quantitative information, further

study will have to be carried out to fairly assess whether similar incorporations of e-Portfolios improve students' communication skills.

Conclusion

Incorporating e-Portfolio into a mathematics/statistics course is a challenging task with much potential in transforming traditionally theory-oriented courses to ones driven by authentic examples. Such potential is more apparent in courses intended not to provide training to future mathematicians but to equip a diverse audience with essential numeracy literacy. While technical aspects and students' lack of understanding of the underlying rationale probably will remain major obstacles in the near future, the digital and online nature of e-Portfolios surely makes it more feasible for instructors to facilitate sharing and collaboration among students. With the encouraging feedback and experience from this small-scale implementation, it is hoped that this case study will trigger more similar endeavors by fellow mathematics educators.

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