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The Engineering Eportfolio: Enhancing Communication, Critical Thinking and Problem Solving and Teamwork Skills?

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***Abstract*—**Graduate attributes have received increasing attention over recent years as universities incorporate these attributes into the curriculum. Graduates who have adequate technical knowledge only are not sufficiently equipped to compete effectively in the work place; they also need non disciplinary skills ie, graduate attributes. The purpose of this paper is to investigate the impact of an eportfolio in a technical communication course to enhance engineering students' graduate attributes: namely, learning of communication, critical thinking and problem solving and teamwork skills. Two questionnaires were used to elicit information from the students: one on their *preferred* and the other on the *actual* learning process. In addition, student perceptions of the use of eportfolio as a learning tool were investigated. Preliminary findings showed that most of the students' expectations have been met with their actual learning. This indicated that eportfolio has the potential as a tool to enhance students' graduate attributes.

***Keywords*—**Eportfolio, Communication Skills, Critical Thinking and Problem Solving Skills and Teamwork Skills

I. INTRODUCTION

GRADUATE attributes have received increasing attention in Malaysia [1], [2] and internationally including Australia ([3], [4], [5], [6], the United States of America [7], [8] and the United Kingdom [9], [10]. The role of graduate attributes is highlighted particularly in higher education for over a decade [11], [12], [13]: these graduate attributes are important, too, for the government, employers, society, and curriculum developers [14].

Graduate attributes are the set of qualities and skills predetermined by a university that students should develop and acquire from the institution which later contribute to their career [15]; they are also known as soft skills in Malaysia [16]. These skills include communication skills, teamwork skills, critical and problem solving skills, ethical moral and professional skills, entrepreneur skills, life-long learning and information management skills, and leadership skills [16]. Graduates who have adequate technical knowledge only are not sufficiently equipped to compete effectively in the work place; they also need non-disciplinary skills, especially graduate attributes.

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Engineering students develop technical knowledge in order to be certified as engineers but they also need additional, broader attributes in the workplace. These graduate attributes include oral and written communication skills, teamwork skills, critical and creative thinking skills and problem-solving methods [17]. Engineers need these attributes in order to fulfill the demands of employers.

According to Vijan [18], for example, graduates lack the skills of presentation and communication and therefore they were not able to impress employers during interviews. Malaysian universities also reported that they are not producing work-ready graduates because their education system is too exam-oriented [19], [20]. They produce graduates who are competent technically but lack graduate attributes. Another reason is related to the mismatch between what the universities are producing and what the Malaysian job-market seeks [21], [18], [22]. According to Sibat [23], graduates were unemployed not because they were not competent but rather because they lack graduate attributes that have been neglected in the educational system. This is because prior to 2006, graduate attributes were not incorporated into the university curriculum in Malaysia. A report by World Bank [24] claimed that there was a relationship between the workplace and university education. Findings from Tracer Study of Graduates [25] and commissioned research [26] stressed that tertiary education institutions should embed graduate attributes including language, team work, and problem solving into the curriculum. This is because these skills are considered to be the most critical skills in the recent global job market especially in a fast moving era of technology [16].

II. AIM

The broad context for this study is that all Malaysian public and private universities were asked to incorporate graduate attributes into their curriculum from August 2006 [16]. Assessing student achievement of the attributes is therefore important. One way to assess students' achievement is by introducing eportfolio. Eportfolios can improve learning but the process of learning using eportfolios has not been thoroughly researched and so there is little evidence to support existing claims [27], [28]. Findings from previous studies do not reveal explicitly how the students' learning benefited as a result of using the eportfolios. Therefore, this study fills a research gap by investigating the impact of embedding an eportfolio into a technical communication course. The study examined the learning process and used the students' voice to

test the assertion that eportfolio might contribute to more effective learning in terms of communication skills, critical thinking and problem solving skills and teamwork skills. The research, conducted in one of the universities in Malaysia, gathered both qualitative and quantitative data to test this assertion. This paper focuses on the findings from learning process questionnaires. The research questions which guided the investigation are:

To what extent does an eportfolio enhance students' graduate attributes; in particular:
(i) communication skills?
(ii) critical thinking and problem solving skills?
(iii) teamwork skills?

The structure of the questionnaires is provided below.

III. METHOD

The objective of the questionnaires was to find out if graduate attributes, particularly communication skills, teamwork skills and critical thinking and problem solving skills have been enhanced when they use the eportfolio as a learning tool in a technical communication course. These are three of the graduate attributes required by the Malaysian government of university graduates.

The study examined the learning process in developing an eportfolio by adapting the Plan-Do-Review cycle [29] as shown in Fig. 1. This cycle incorporates both the approaches of Kolb's Experiential Learning Cycle [30] and Action Learning [31], as outlined in Pallister [29]. These two approaches are based on constructivist learning principles [32]. This cycle involves student-centred learning and the student has to become active, critical and reflective in his/her learning and to take responsibility for their learning. It fosters authentic learning when students are placed in the centre of the learning process and actively engaging in constructing eportfolios and gain the experience of the learning by planning, selecting, reflecting and sharing the artifacts [33].

The research instrument used for this survey is two forms of the questionnaire: *preferred* and *actual* learning process questionnaire [34]. The *preferred* form allowed students to give opinions about their ideal or desired learning in the classroom while the *actual* form assessed students' *actual* experience of the learning process and perceptions on the use of eportfolio in the classroom. The questionnaires were administered to the 66 students to find out their perceptions on the use of eportfolio has any effects on students' interpersonal communication skills, reflection and collaboration and also about their perceptions on the use of eportfolio in the classroom environment. This questionnaire was adapted from Constructivist Multimedia Learning Environment Survey (CMLES) [34].

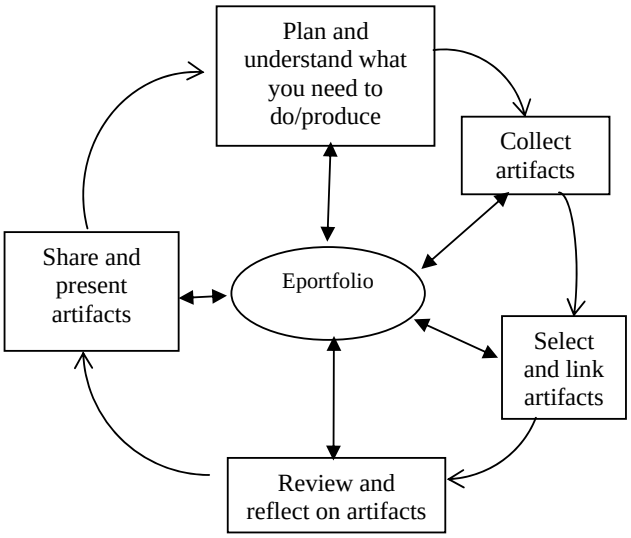

Fig. 1 The eportfolio process as a 'Plan–Do-Review' cycle (adapted from Pallister, 2007)

The questionnaires were distributed to the same students before and after their eportfolio experience. Surveys were administered in the second week of the semester and in the second last week of the semester, after students had completed all the assignments required for assessment. Each of the questionnaires took about 20 minutes to complete.

There were three sections in the questionnaire: I. Background Information; II. Interpersonal Communication, Reflection and Collaboration; III. Students' perceptions about the use of eportfolio in Technical Communication Course. Section I sought background information such as student gender.

Section II investigated three graduate attributes namely, Interpersonal Communication (Communication skill), Reflection (Critical thinking and problem solving skill) and Collaboration (Teamwork skill). There were five items in each scale. In the Interpersonal Communication Scale, questions asked students about interactions with their peers and work in the classroom. In the Reflection scale, students were asked about how they reflected while constructing the eportfolio. The last scale for this section is Collaboration where students were asked how they worked together in achieving their aims and improve their own learning. Students were also asked to write any additional comments they wished in the space provided after each scale.

In section III, students' further perceptions were sought about the use of eportfolio. The questions were constructed to investigate students' perceptions of how they use eportfolio collaboratively in facilitating and generating learning. The scales in section III were: Relevance, Ease of Use and Challenge, with five items in each scale. Each scale had a five-point Likert scale as follows: Almost never (1), Seldom (2), Sometimes (3), Often (4), Always (5). In the Relevance scale, questions were about the relevance of the eportfolio as a tool in facilitating the students' learning. The Ease of Use scale

aimed to elicit responses about the convenience and usability of eportfolio as a tool in learning. The last scale in this section was about Challenge where students were asked whether the eportfolio could challenge them to enhance their learning. The students were also encouraged to write in any additional comments they wished to make after each scale.

Students were asked additional questions in the *preferred* questionnaire including: What do you hope to learn from using eportfolios in this Technical Communication course? The *actual* questionnaire included these two specific questions:

1. What have you learnt from using eportfolios in this Technical Communication course?
2. Do you have any negative experience(s) from using eportfolios in this Technical Communication course? If yes, please explain.

IV. Results and Discussion

Section I of the questionnaire confirmed that the participants in the study comprised one class of 66 students, with 56 male and 10 female undergraduates. These students were second year engineering students who took a technical communication course as a requirement of their programme. They were aged 20 to 22 years old and mostly Malays and Chinese.

Section II findings are summarized in Fig. 2: the *preferred* and *actual* scale mean scores. The preliminary results suggest that students' preferences were higher than they perceived actually happened in the classroom. The scale means for the *preferred* and *actual* forms indicates that students generally perceive a high level of Interpersonal Communication, Reflection and Collaboration. The results showed statistically significant differences for the three scales: they were, respectively, ($t = 2.65$, $p = 0.01$), ($t = 4.57$, $p = 0.00$) and ($t = 2.84$, $p = 0.004$). In spite of this, analysis of the student responses to the open questions suggested that most of the students' expectations have been met with their actual learning. That is, the data from the open-ended questions supported the idea that there was no *educational* difference between student expectations (*preferred* form) to their experience (*actual* form).

In relation to the learning processes identified by the first three scales when using eportfolio in the course, there was a general perception among the students that they were *Often* engaged in Interpersonal Communication, Reflection and Collaboration and also the similar results obtained for the students' preferences. This showed that while working on the individual eportfolio, students had the opportunity to engage in the learning process with their peers and facilitator.

The open-ended section of the questionnaire provided additional perspectives of students' experiences with the eportfolio.

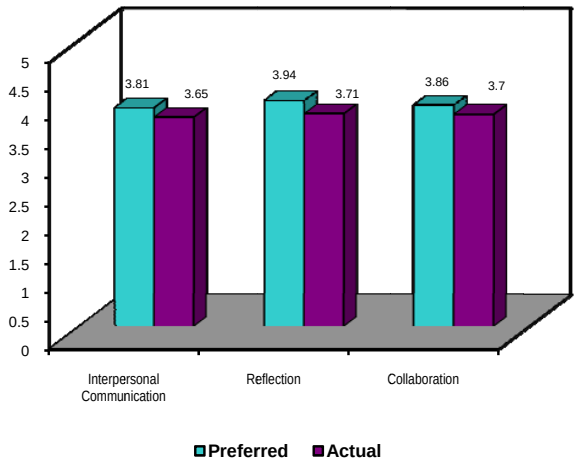

Fig. 2 Scale means for *preferred* and *actual* versions of Interpersonal Communication, Reflection and Collaboration

In the *actual* form, a student observed that his/her oral communication skill has improved when using eportfolio in the course:

"*I can improve my English communication skill through this eportfolio. It has taught me that there is more to effective communication than just verbal and writing communication. After all, I have come to realize the great importance of being a good and effective communicator in our daily lives*." (S58)

Three students also claimed that they were able to explain their new ideas and interact with their friends. This enabled them to improve their eportfolio and have fun at the same time:

"*I learn how to express my feeling, changing ideas with my friend and I got a chance to interact with them.*" (S10)

"*I had learn many useful stuff in using this eportfolios. I can discussed with others students how to made my eportfolio better and better. Besides that we can discussed about our ideas to made it more fun*." (S66)

"*I have learnt how to improve my writing in English, share about cover letter and resume with friend also to improve and explain my ideas in eportfolios*." (S42)

The students in general demonstrated that they had improved their interpersonal communication skills. They were able to explain their new ideas and interact with their friends, share their ideas and artifacts with their peers, give and get the feedback from their peers and this has resulted a positive outcome in their learning. They had also learnt how to post, edit and comment on their peers' eportfolio and understood better of how to do the eportfolio and improved their eportfolio. Two students also expressed that the learning process has enabled them to foster relationship with their peers

too:

"It can be used to describe people especially ourselves easily. It cause people to become closer to each other and it helped me to think that it is easier to have information and give information through internet." (S43)

"*When asking friends to help about the blog can help to foster relationship and help us improve the communication skill."* (S41)

The students suggested that their critical thinking and problem solving skills have improved when using eportfolio in the course. Two students believed that they had critically reflected on their own learning as they were able to generate new ideas in their learning. They also found that by viewing their peers' blog and reflecting on them had allowed them to generate their ideas better. They claimed that the peers' feedback had helped them better in the process of learning:

"Through eportfolio, we can learnt about how to generate idea, example in the blog, after gather information and view peer's blog will generate new idea on blog. Then also can reflect about what's the 'things' that we still needed to add for ourself, in resume or eportfolio." (S62)

"*I have learnt and practiced a process by using eportfolio in this course. We have learnt how to built in and generate a new idea at a high level to make up my blog."* (S58)

The students reported that their teamwork skill has improved when using eportfolio in the course. For example, two students got to reflect on their own learning when browsing their peers' eportfolio:

"*In this class, usually me and my friend need to view others blog to read their reflection and sometimes, I can have new idea due to their blog. For me, an idea is very important because no idea means boring life."* (S43)

"*Through eportfolio, we can learnt about how to generate idea, example in the blog, after gather information and view peer's blog will generate new idea on blog. Then also can reflect about what's the things that we still needed to add for ourself, in resume or eportfolio."* (S62)

Many students said that they improved their learning when reading their peers' eportfolio as they were able to generate new idea and improve the contents of their eportfolio. The students also mentioned that they were able to share their learning with their peers when they published their artifacts in the web. The students also added in the open-ended part of the questionnaire that they had reflected more effectively on their learning due to the feedback from their peers. They were able to exchange views on their work, learn their mistakes and get a better understanding on the tasks done.

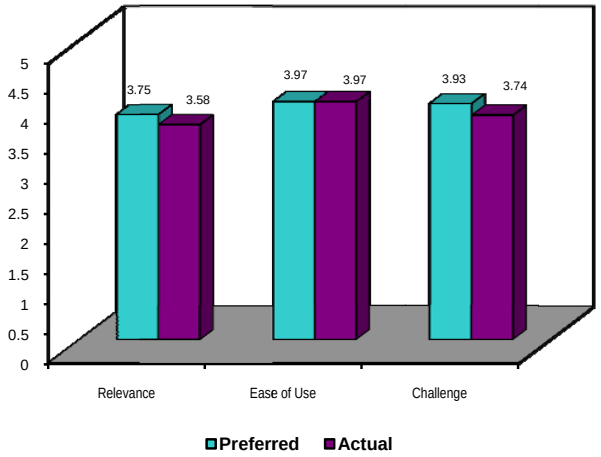

Fig. 3 Scale means for *preferred* and *actual* versions of Relevance, Ease of Use and Challenge

Section III findings are summarized in Fig. 3: the *preferred* and *actual* scale means scores for Relevance, Ease of Use and Challenge. Students generally indicated high preferences for Relevance and Challenge. The frequency of the average responses for Relevance and Challenge items were close to *Often*, suggesting that students expected that the use of eportfolio to present information in a relevant way (mean = 3.75) and to expect the use of eportfolio to challenge their ideas (mean = 3.93). In practice, students perceive that *Often* the use of the eportfolio initially presented the information in a relevant way (mean = 3.58) and was able to challenge their ideas (mean = 3.74). It is interesting to note that those students had the same mean (mean = 3.97) for their *preferred* and *actual* learning for Ease of Use.

Most students claimed the use of the eportfolio has offered authentic information in the course and a representative of real-life situations. The students were required to produce cover letter, resume and recommendation report as a part of the course assessment. Thus, they could present their resume, cover letter, recommendation report, article and research which served as their authentic artifacts in their eportfolio. A paired t-test showed that the use of eportfolio in the course did elicit a statistically significant change in actual-preferred Relevance scores ($t = 2.91$, $p = 0.004$). They could present their artifacts in meaningful ways and relevant to their learning. They learnt to express their new ideas and present artifacts to their peers. They also received feedback from their peers and thus, improve on each other's learning. Two students learnt how to upload the artifacts that contained their students' activities, organize their artifacts and published them in their blog:

"I learn how to upload artifact to blog and shows to others peer. From eportfolios, I get know what mistakes I done when I finished done my artifact from my members comment. I get some information from the eportfolio how to do my artifacts." (S50)

"I learned some new things such as I can gather many useful information from other peer's eportfolio, I can exercising my mind on generating ideas, I can provide and insert useful information, I can interact with other and discussing about our own eportfolio and in fact, I can also know some new things on how to use the eportfolio." (S34).

Other students stated that the use of the eportfolio was not complex as the eportfolio was easy to post and respond entries:

"*Eportfolios was easy to use. It helps me in presenting my resume, report and etc. My communications with teammates improved*." (S45)

"*I have learned a lot of things from using this eportfolio. Even though this is my first time but its not so hard for me to learnt on how to use it. The most important things is I be able to give response to my work and get response from other*." (S19)

Most students also used the eportfolio to represent data in a variety of ways. For example, they learnt how to present ideas and publish their artifacts in the web. A paired t-test showed that the use of eportfolio did not elicit a statistically significant difference in actual-preferred Ease of Use scores ($t = 0.1$, $p = 0.76$). This shows that there was no difference in the score and thus, indicated that the use of the eportfolio had no impact on the Ease of Use. This was because the eportfolio was easy to use and navigate. Thus, they were easily comment on their peers' work and received feedback from their peers. The students also mentioned that it was fun to use the eportfolio and discovered that the eportfolio allowed the tools like video, audio, and images to be included. They published their artifacts in the web and allowed sharing with their peers. Thus, this improved their own work. Students found it easy to use when they had learnt it:

"*Even though the eportfolio is complex at first, the usage seems to be easy after I get used to eportfolio.*" (S35)

"*By using this eportfolios also, it makes things goes easier to me. More knowledge also had been gained by doing this such as creating our own blog.*" (S14)

The students also noted that initially it was a challenge to use the eportfolio. Later, they found out that the eportfolio was easy to use when they had learnt how to use it. A paired t-test results showed that the use of eportfolio did elicit a statically significant difference in actual-preferred Challenge scores ($t = 3.48$, $p = 0.00$). This shows that there was a difference in the score and thus, indicated that the use of the eportfolio had a positive impact on the Challenge. They said that there would be no boundary for them to expand or widen their creativity thinking in using the eportfolios. The eportfolio also polished their creativity skills. The eportfolio also helped students generate new ideas and artifacts. They felt the challenged and enjoyed using it in the class. Thus, the use of eportfolio had a positive impact on the students' learning. Two students stated that the eportfolio was challenging to use in their learning.

They elaborated that the eportfolio was challenging to use in their learning. They found that it needs time to explore and view others' blogs in order to generate ideas. One suggested having a group blog rather than individual blog:

"*The truth is, eportfolio is a great tool. But, it need a lot of experience and need to view others people blog constantly to generate and find out the new idea*." (S43)

"*It is challenge when we know nothing before this because need to survey. In my opinion, encourage a group discussion to produce and design a high quality blog better than individual. Next time only produce individual if needed.*" (S62)

On the other hand, some students had also encountered some minor disadvantage. One student was unsure of the function of the eportfolio and this had made him lost interest in the eportfolio:

"*My big problem is lack of knowledge on how to use the function on eportfolio. So, I still confuse on the function of some application causing me to lose interest in it.*" (S43)

A small group of students encountered some issues related to internet and computers. They did not have time to update their blog because they did not have internet in their hostels, experienced low speed of internet connection in the lab and also experienced issues with the internet connection. Some complained that they were busy with their work and did not have time to update their eportfolio.

V. Conclusion

The study investigated whether the use of an eportfolio would enhance the following graduate attributes: communication skills, critical thinking and problem solving skills and teamwork skills. The eportfolio process 'Plan–Do-Review' cycle was used as the framework for this research. In this paper, the data gathered from one aspect of the research, namely the two forms of the questionnaire are presented. The preliminary data analysis suggest that the use of eportfolio had a positive impact on the students' learning. Further, the results of quantitative data were supported by responses to the open-ended questions. The findings of the study suggest that eportfolio has the potential as a tool to enhance students' graduate attributes. In the longer term, this study may provide evidence which could contribute to higher education policy in Malaysia regarding the incorporation of graduate attributes.

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