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The Use of Academic Portfolio in the Learning and Assessment of Physics Students from a Singapore Private College

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Abstract

The purpose of this perspective paper is to examine the use of portfolios in the teaching and learning of physics in a Singapore private college. The paper starts with a short introduction of the types of students and the purpose of using academic portfolios in their learning and assessment. Some ideas of how portfolios can be used in the local context will also be discussed. It is necessary for teachers to know how to incorporate portfolio assessment in their daily lesson plans. At the same time, students who are studying physics at the college should also know how to use portfolios to their academic advantage. The paper also highlights three of the relevant work artifacts that can be included into the physics portfolios. The three work samples are concept-maps, internet research reports and newspaper articles reports. Concept-maps are useful tools to help students establish the connections between concepts. Internet research reports serve as important means for students to know more about how some scientific devices or technology use physics in the operations. Newspaper articles reports allow students to understand the real impact of physics on the lives of people. Subsequent sections of the paper discuss about the organizational flow of the portfolio, the timeline, the selection process, the portfolio checklist and assessment rubrics, the positive influences of using portfolios, the issues to consider and also the potential problems that physics teachers may face in implementing portfolios. These sections present the important framework which teachers can use as references for their portfolio initiatives in schools.

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1. INTRODUCTION

Portfolios are defined as the collection of an individual's work in a purposefully regular manner. In the education context, academic portfolios refer specifically to the consolidated works of the students. Therefore, the use of academic portfolios serves the important function of allowing students to showcase their best works and to demonstrate what they actually know of the subject.

1.1. Students enrolled in Singapore private colleges

There is a need to distinguished between private international colleges which offer the International Baccalaureate (IB) diploma or the IGCSE programs from private colleges which

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offers the GCE 'O'/'A' level preparatory courses and the commercial diploma or degree courses. The college mentioned in this perspective paper is the latter.

There are many private schools in Singapore which offers external degree and diploma programs, as well as GCE 'O' level and 'A' level preparatory programs. Generally, students who are enrolled in the GCE 'O' level preparatory courses are less academically inclined. They lack the essential skills to present their answers or explanations properly so as to do well in written examinations. In this sense, traditional standardized testing may not be the best way to assess the level of content mastery of the students.

This paper attempts to present several perspectives of how academic portfolios can be used to replace traditional assessments to assess the mastery level of the students who are studying physics at a Singapore private college. For example, the academic portfolios can serve as a platform for students to showcase how much they actually know about a particular physics topic. Concept-maps to establish linkages between physics ideas and relevant artworks can also be included as work samples in the portfolios.

It is hoped that the suggestions and ideas that are discussed in this perspective paper can be used in the future to assess more accurately the academic successes of the students in mastering physics concepts, and possibly even concepts from other scientific subjects.

2. LITERATURE REVIEW

In the recent decades, there has been a significant shift in the selection and usage of tools for educational assessment. Schools, including colleges and universities, are relying less and less on traditional paper-and-pencil tests and developing creative ways to assess the learning of their students. One such example is the use of the portfolios. There has been much research done on using portfolios in the form of formative and summative assessment. The term 'portfolio' started early with the word 'port' to mean carry and the word 'folio' to mean a collection of items such as written documents, drawings, audio or video tapes to showcase one's talent (Olson, 1991). The use of portfolio is particularly useful in certain subjects, such as Arts and Music, which allow the student to showcase what he or she has learnt or developed so far.

Portfolios can be used for different purposes and there are many different types of portfolios. Sandford & Hsu (2013) wrote that there are four examples of portfolios used mainly as: student portfolios; to showcase what the student has learnt over a period of time, teacher portfolios; for teachers to collect their own work to allow for self-reflection and critique, employment portfolios; for established professionals or newly graduated people to showcase their works to potential employers and program portfolios; for the purpose of program evaluation and future marketing by businesses.

There are also researches done on the different stages concerning the implementation of portfolio assessment in the classroom setting. Fouha (n.d) suggested that there are five stages to introduce portfolio assessment, namely: planning, collection, selection, reflection and projection. Planning involves setting of goals and explaining the steps to the students. Collection is to gather all the possible items that students think can be included into their portfolios. Selection stage concerns with the choosing of the most relevant items which best represent the effort. Reflection is the step where students reflect upon their own work in the portfolios. Last but not least, projection is to set new future goals to achieve.

Beside studies done on the various stages and uses of portfolios, there were also more

specific researches done on the use of portfolios for physics students. For example, portfolio assessment was implemented over an eight-week duration to nine nine-graders when they were studying for a physics course. The students' perceptions on their learning journey such as the enjoyable moments, problems faced and benefits gained, were recorded (Ogan-Bekiroglu & Gunay, 2008). The researchers found that the overall experiences of the students about the use of portfolio as assessment were mostly positive. In another study, the researcher attempted to find out if the implementation of the portfolios-based physics learning model improved critical thinking skills (Amin, 2013). The results revealed that the model enhanced the critical thinking skills of the students as compared to students who followed the conventional learning model. The responses of teachers towards the learning and implementation of the portfolio-based physics learning model were also very positive.

The subsequent sections of this paper present personal perspectives on the use of academic portfolios in the learning journey and assessment of physics students.

2.1. Purpose of Physics Portfolio

The purpose of the portfolio is to function as a learning portfolio, with the focus on a subject, in this case, physics. Students will need to demonstrate the amount of knowledge that they have acquired about the subject through the submission of work samples in the portfolios.

2.2. Suggestions of How Academic Portfolios can be Used in the Teaching and Learning of Physics

This perspective paper shall present four ways to use academic portfolios in learning and assessment. The first two ways are related to how students can use portfolios to learn physics, and the next two ways are how teachers can use portfolios to teach and assess the students' level of content mastery in Physics. Physics students can use portfolios as resources to prepare themselves for the written examinations. The creation of work samples reinforces understandings of the various scientific concepts, and this facilitates the study of the subject in preparation for the written assessments.

Students can also use portfolios to demonstrate what they know about physics (Belgrad, Burke & Fogarty, 2008, p. 8 - 9). They need a platform to show people what they know and how much they know about the subject. The use of academic portfolios serves as a good starting point for the students to showcase what they have learnt about physics. On the other hand, physics teachers who are teaching in the college can use academic portfolios to promote subject understanding (Sweet, 1993). They can gain a fairly good idea of how much their students actually know about the subject. This helps to track the learning progresses of the students, and also allows for detection of any misconception in physics at an early stage.

While written examinations remain the main assessment tools for physics in the college, it is largely insufficient to provide an accurate evaluation of the students in the subject mastery. Therefore, educational policy changes see the use of portfolios as an assessment tools. Teachers can now integrate academic portfolios fully into the curriculum, to serve as a form of formative assessment (Sweet, 1993). The portfolio grade can form an integral part of the components to determine the final grade for the subject.

2.3. Possible Work Samples to be Included in the Physics Portfolios

While there are many different types of work samples that can be included in the academic portfolios, not all of them are suitable to be used for physics portfolios. This section highlights three kinds of work artifacts that fit nicely in a physics portfolio.

2.4. Concept maps

Concept-maps are useful learning tools that help learners to establish the relationships between the different concepts in a topic or across various topics. In the learning of physics, students can be given the flexibility to design concept maps according to their level of understanding. Content knowledge is reinforced when they are able to create maps which show the correct connections among the essential scientific concepts, formulas and definitions. For students who are more of visual learners, they can even include drawings and graphics in their concept-maps to illustrate what they know of the topic.

In addition, physics teachers can also use concept maps to assess the level of understanding of the students in the subject. Similar to portfolio assessment, concept map assessment is gaining popularity in recent years as an alternative assessment to the traditional paper-and-pencil tests (Thor, Boo & Yap, 2007). Hence, teachers may wish to explore the use of both concept-mapping assessment and portfolio assessment to evaluate the academic achievements of the students in physics.

2.5. Newspaper Article Reports

The writing of newspaper article reports is another excellent work sample to be included in a physics portfolio. Students can pick up newspaper articles that are relevant to the subject of physics, and produce short essays about the topics in the articles. This activity is beneficial to students who are less academically-inclined, as they will be able to see and explain for themselves the applications of physics concepts in the real world, instead of simply reading them from the textbooks.

2.6. Internet Research Papers

The Internet is another rich resource to produce excellent work artifacts for portfolios. The teacher can provide a list of physics topics that can be examined by the students, and provide clear instructions for them to go online to search for relevant information. Students can then create sample writings in the form of research papers (Purdue University, 2011), complete with graphical illustrations, with explanations of how things occur in relations to physics concepts. This will help to build up their understanding of physics applications in real life, and the reports can be filed in together with other works in the portfolios.

Other possible physics portfolio components include laboratory reports, physics journals and self-reflections. The decision to include some or all of the above work samples in the final portfolio is closely related to the purpose of the portfolio (Belgrad, et al., p. 106).

2.7. Organizational Flow and Timeline of the Portfolio

The organizational flow of the portfolio involves three basic but essential steps – collection, selection and reflection (Belgrad, et al., p. 101). The ‘collection’ step involves the collection of all possible working samples that the students can produce within the given timeframe. It is advisable to instruct the students to gather all their works because teachers may not know in advance the portfolio requirements. The ‘selection’ stage requires all students to

select their best relevant artifacts to be included in the portfolios that will meet the purposes. The third step is to get students to conduct reflections of how the selected work samples are connected to the learning objectives of the subject (Belgrad, et al., p. 101).

In addition to these three steps, two other stages have to be included to cater to the learning needs of the students. One of the steps is the 'introduction' step. This step is to be done before the 'collection' step. Physics teachers need to formally introduce the use of portfolios for the subject to the students. This should be done within the first two lessons at the beginning of the school year. During the introduction phase, teachers need to explain the purpose of using portfolios, the benefits of portfolio building, the use of portfolio as a form of formative assessment, the types of work samples to be included in the portfolios, the tentative portfolio conference schedule and possibly, the assessment rubrics (Belgrad, et al., p. 166 - 172). Students are also encouraged to use this time to seek clarifications from the teachers so that they can better understand how to build proper portfolios.

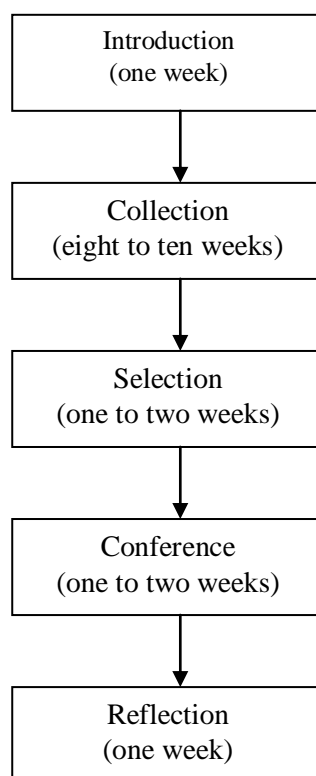


Figure 1. The organizational flow and timeline of the physics portfolio

The second step to be included is the 'conference' step. This step is to be done after the students have built their final portfolios, but before the stage of 'reflection'. When students have completed their portfolio building, a final portfolio conference needs to be conducted with the teachers. During the conference session, the teachers will discuss and evaluate on the quality of the portfolios. This step is necessary because students need specific advices and verbal instructions before they know how to conduct reflections of their works.

The entire portfolio building and evaluation activity should take place within a timeframe of about three to four months. The ‘introduction’ step should take one week. The ‘collection’ step, which is where the main learning process will take place, will take about eight to ten weeks. The ‘selection’ step should require one to two weeks for the students to decide on which work samples to be included in their final portfolio. The ‘conference’ step should need one to two weeks, and the ‘reflection’ step will need only one week.

2.8. Portfolio Selection Process

To discuss the portfolio selection process, we need to address four questions: What should be included? How should the samples be selected? Who is going to select the samples? When will these samples be chosen? (Belgrad, et al., p. 106)

What work samples should be included in the physics portfolio? The objective of the portfolio decides which work items are to be selected to form the final portfolio (Belgrad, et al., p. 106). In this case, the purpose of the portfolio is to allow physics students to demonstrate their level of content mastery in the subject. Therefore, the best work samples to be included are concept-maps that show relationships between the various physics concepts, newspaper article reports, physics laboratory reports and relevant internet research reports. These work samples are excellent items to showcase how much they know of the subject. How should the samples be chosen? The items that best exhibit the level of understanding of the subjects should be selected. Comparisons can be made between the different samples to decide which ones will go into the final portfolio. For example, if the more recent concept-maps contain better connected diagrams as compared to the earlier versions, then the latest maps should be included in the portfolio. Similarly, if the initial newspaper reports present clearer explanations of the scientific concepts than subsequent ones, then the earlier versions of the reports should be selected.

Who is responsible to select the work samples? As the purpose of the portfolio is for the students to demonstrate physics content mastery, it is advisable to encourage students to conduct the first round of selection. The second round of selection can be done by the physics teachers to finalize the items in the portfolios.

When will the selection be done? According to the organizational flow of the portfolio building process, the selection should be conducted about three months after the initiative has been introduced. This allows ample time for the students to collect and compile all the work samples, and get the items ready for the selection.

2.9. Assessment Rubrics and Checklists

Teachers can design checklists to guide students in their portfolio building processes. A checklist shows the essential steps that the students need to do so as to prepare their portfolio ready for the final assessment. Such checklists will be useful as the students need step-by-step guidance on how to go about building their portfolios. An example of a checklist is shown in Table 1 above.

Portfolio assessment rubrics are designed to evaluate the qualities of the physics portfolios during portfolio conferences. In order to make the conferences more time-efficient, teachers can pass a similar assessment rubric to the students and instruct the students to conduct their own internal evaluations before the conferences (Popham, 2000, p. 302). This will facilitate the conduct of the portfolio conferences as the teacher is able to begin the discussions by focusing on the topics that may be of most concern. Letter grades or point values can be allocated for each

criterion in the grading rubrics (Belgrad, et al., p. 172). An example of a portfolio assessment rubric is shown in Table 2 below.

Table 1. Checklist for Physics Portfolio

Dear student, before you submit your final portfolio for assessment, check that you have done all of the following:		
S/No	Checklist indicators	Done
1.	The portfolio content page is up to date.	
2.	The work samples are arranged with the latest artifacts on top	
3.	The best samples have been selected and included in the portfolio.	
4.	At least two concept-maps are included in the collection.	
5.	At least two laboratory reports are included in the collection.	
6.	At least two scientific reports are included in the collection.	
7.	At least one newspaper article report is included in the collection.	

Table 2. Assessment Rubrics for Physics Portfolio

Objective: to use the indicators and criteria for the final portfolio assessment.				
Criteria	Poor 1	Average 2	Good 3	Excellent 4
Selection of artifacts that meet the purpose of the portfolio	Very few artifacts have met the purpose of the portfolio.	Some artifacts have met the purpose of the portfolio.	Most artifacts have met the purpose of the portfolio.	All artifacts have met the purpose of the portfolio.
Organization of the portfolio	Structure of portfolio is not organized. Needs a lot of improvement.	Structure of portfolio is organized, but needs some improvement.	Structure of portfolio is fairly well organized.	Structure of portfolio is very well organized. Excellent!
Qualities of the work samples	Samples show total lack of understanding of concepts.	Samples show some basic understanding of concepts.	Samples show adequate understanding of concepts.	Samples show in-depth understanding of concepts.
Varieties of work samples	There is no variety of work samples. (Only 1 type is submitted)	There are insufficient varieties of work samples. (2 to 3 types submitted)	There are sufficient varieties of work samples. (4 types submitted)	There are more than sufficient varieties of work samples. (more than 4 types submitted)
Reflections of work samples	Little evidence of self-reflection.	Some evidence of self-reflection.	Evidence of realistic self-reflection.	Evidence of realistic, thorough and constructive self-reflection.
Comments :				
Final Score : _____[Scale: A = 17 – 20, B = 13 – 16, C = 9 – 12, D = 1 - 8]				
Final Grade: _____				

2.10. Positive Influences of the Use of Academic Portfolios

The use of academic portfolios in physics at a Singapore private college serves as a starting point to boost the confidence of the students in the subject. Unlike students who are studying in public schools, students studying at private colleges are generally less academically-inclined. Some of them have experienced a history of examination failures, and many of them lack the motivation to want to do well in life.

When students are given the opportunity to demonstrate what they know of the subject, it gives them the incentives to want to learn more. This will naturally influence them to create work samples which can best represent their level of knowledge. In the process of doing so, the content mastery of the subject will be strengthened, and this improves their achievement levels in physics. It is also possible that the students may learn the concepts more effectively, and are more able to visualize and relate the works that they and their friends produce to the scientific theories that they have been introduced (Cakan, Mihaladiz & Gocmen-Taskin, 2010).

It is also important that at the beginning of the initiative, teachers emphasize that part of the final internal preliminary examination grade for physics will come from the portfolios. This will provide the additional bonus for the students to devote more time to build their portfolios.

2.11. Issues of Portfolio Implementation

Before the introduction of the physics portfolio, three issues have to be considered. The first issue is to examine the needs, benefits and problems of implementing portfolio assessment. Teachers must not be in a hurry to introduce portfolio assessment to the students until they have studied the needs for using portfolios in the learning and teaching of physics. The second issue is to decide who should ultimately view the portfolios. Will the parents, students themselves or the school administrators be permitted to read the contents? The third issue is the storage of the portfolios. Teachers must think about who should be responsible for ensuring the safe keeping of the portfolios so as to avoid losing the work samples.

2.12. Potential Problems Faced by Teachers and Students in Portfolio Implementation

Due to the quality of the students and the nature of teaching work at private colleges, it is not easy for physics teachers to introduce portfolio assessment. There are several potential problems in the implementation of the initiative.

The first problem is the low attendance rate of the students. Students studying in a private school have the option not to turn up for classes as long as they have valid reasons. It is, therefore, common for a class to have only fifty percent attendance. While portfolios are supposed to increase the learning motivation of the students, it is difficult for teachers to monitor their portfolio building progresses when the students do not turn up regularly for lessons.

The second problem is the weak academic abilities of the students. Due to their poor foundations in physics, it will be a challenging task for the students to produce well-designed concept-maps that are able to show the intrinsic connections between the various concepts or to create well-written research reports on specific scientific themes. Teachers must be flexible to adjust their expectations of the qualities of work samples that the physics students are capable of developing. As and when appropriate, the evaluation rubrics must be amended to fit the learning progresses of the students.

The third problem is the lack of collaboration and communication among physics teachers at some private colleges. Many of the teachers teaching at Singapore private colleges are

employed on a part-time basis, with different timetables. This imply that it is difficult to get all the physics teachers together to discuss about the issues that each of them is facing when it comes to implementing the portfolios. The only point of contact is the assistant managers who are providing the necessary academic support to all the teaching staffs. However, this will mean that communication will mostly take place via emails, and this will slow down many of the processes.

3. CONCLUSIONS

In an effort to promote the use of portfolios in the teaching and learning of physics at private schools, this perspective paper presented some ideas of how to implement the initiative. Four ideas were presented, with two for teachers and two for students. Teachers can use portfolios to track the learning progress of the students who are taking physics. They can also use portfolios as a form of formative assessment to evaluate the level of understanding of the students. On the other hand, students can use their portfolios as preparation guides to prepare for the written examinations. They can also make use of the physics portfolios to demonstrate how much they actually know of the subject.

This perspective paper also mentioned about the appropriate work samples that can be included in the physics portfolios. Not all work samples are suitable to be included in the portfolio. It depends, to a large extent, the purpose of the portfolio. In this case, the objective of implementing the portfolio is to allow students to showcase how much they know and have learnt about the subject. Therefore, concept-maps, internet research reports, newspaper articles reports and laboratory reports are materials that the physics portfolios can contain.

It is also important to understand the organizational flow and timeline for the implementation of the portfolio. The proposed flow consists of five steps – introduction, collection, selection, conference and reflection. The ‘introduction’ step is to serve as a starting point to provide the essential instructions to the students so that they will understand what they are supposed to do. The ‘conference’ step is the time when the teachers will sit down with the students and evaluate the qualities of the portfolios. This step should be done before the ‘reflection’ step as the students will generally require more verbal feedback from the teachers before they can self-reflect on their own works.

The proposed assessment rubrics and checklist are necessary to provide the framework for physics teachers to use as references when they are evaluating the portfolios. Students can also benefit from the materials as they will have a better idea of how their artifacts are being graded. Hopefully, this may help them develop the self-reflection skills so that they are able to produce better samples in the future.

The paper also touched on the influences of portfolio assessment on the students. One of the main advantages of implementing portfolio is the increase in the motivation to learn. When students are given the chance to demonstrate what they know of the subject, it may spur them to create good quality artifacts to be included in the portfolios.

It is also important for teachers to consider some of the important issues when implementing portfolio assessments for learning and teaching of physics. The three issues discussed were: to examine the benefits, needs and problems of portfolios before making the decision to implement it, to decide on the people who are allowed to view the portfolios, as well

as the storage of the portfolio artifacts.

Finally, we must not neglect the potential problems of implementing portfolios in the college. The first problem is the low attendance rate of the students. When students fail to turn up for lessons, it is difficult for the teachers to track their learning progresses. The second problem is that the students may not have the essential foundations to create well-designed portfolio artifacts. Teachers must offer their help as and when it is necessary so that students know how to move on in their portfolio building paths. The third problem is the lack of opportunity for teachers to come together to discuss about the issues relating to portfolio implementation.

Although it is not easy to implement portfolio building and assessment, it is hoped that the ideas and suggestions in this paper can serve as a starting point for such an assessment to take place. It requires the effort from the students, teachers as well as the supporting staffs in the school. Ultimately, the students are the people who will benefit from the portfolio building processes.

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