Incorporating Real World Phenomena in a Multimodal Authentic Transfer Task

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Abstract

A year-long multimodal Authentic Transfer Task centered on the Understanding by Design framework was designed and implemented for 185 Grade 9 Physics students in National Junior College, Singapore. Instagram was used as a starting platform to motivate students on a self-directed journey in discovering Physics phenomena. Students' learning was differentiated through the ability to select the phenomenon and topic in which they would like to focus on. Scientific communication skills were emphasized throughout the entire period through various methods. Students' conceptual understanding was deepened through questioning by peers and tutors. Learning was consolidated with reflections on student's individual learning process. Project is sustainable as prototypes can be collated and used as learning resources for future cohorts. Students' conceptual gain and feedback towards the learning process was collated through a questionnaire. This mode of learning was found to have improved students' passion and conception understanding of Physics. A discussion on the affordances of the method with regard to student engagement and conceptual understanding, from both the teacher's and students' perspectives, is presented in the paper.
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Introduction

Physics has always been quite a daunting subject for Grade 9 students in Singapore due to the transition from General Science in Grade 8 to a more rigorous treatment of Physics in Grade 9. Students have to specialize in the different sciences and Physics is usually thought to be an entirely new subject. The increase in the rigour of the subjects between Grade 8 and 9 plays a part as well. Students often find it difficult to see the connections between Physics and the real world, and this results in a myopic view of Physics as a discipline that only requires qualitative answers. This phenomenon of students losing interest can be observed in other countries as well and most of the time it can be attributed to a teacher centered transmissive pedagogy (Lyons, 2006), even when educators seek to deepen students’ understanding, passion for the subject and appreciation for Physics as a whole.

The National Junior College Junior High Science department seeks to get all students to think and communicate collaboratively, creatively & critically in Science, and to get them to demonstrate their passion for Science by ethically engaging in the practice of Science. With these objectives in mind, this research aims to increase students’ conceptual understanding of Physics behind daily Physics phenomena, and to inculcate in students the passion for Physics. The project was a year-long project and it was an alternative assessment for Grade 9 Physics students in National Junior College. The project employs Stage 2: assessment evidence of the Understanding by Design (UbD) framework to determine the acceptable evidences of learning based on the learning goals that have been set for the
students (Wiggins & McTighe, 2005). Using an Authentic Transfer Task (ATT) was one of the ways that was suggested by Wiggins & McTighe. It allows us to assess our students based on goals that we want our students to achieve and the desired evidences that we want to collect. An ATT is different from the pen and paper assessment as it is usually presented in a form of a real world problem to the students. The problem chosen for the ATT is usually framed by the teacher such that it is realistic and manageable to the students. Students would be given an identified audience and are expected to create a product or performance. There would be an evaluation phase at the end of the ATT and students would be told of their criteria in the beginning of the task. (Wiggins & McTighe, 2005) In this project, in order to collect desired evidences, the students were required to produce certain artefacts during and at the end of the ATT.

A key feature of the ATT is the incorporation of knowledge building using the social constructivist theory of knowledge (Vygotsky, 1986). Based on this approach, students worked collaboratively to apply abstract Physics concepts to real-world scenarios. The use of real world experiences and contexts provides students with a meaningful backdrop for them to test and challenge the scientific concepts they have learnt in class. This real world context allows them to discover and confront their everyday prior conceptions, and helps them to better appreciate and more deeply understand the scientific concepts.

Multimodal learning strategies, in line with Howard Gardner’s Theory of Multiple Intelligences, were also employed to more effectively target the diverse learning modes of our students (Howard, 1999). A whole myriad of tasks, including Instagram posts, logbooks, presentations, construction of demonstration sets, and posters - were embarked by the students in the course of the authentic transfer task. The diverse nature of the assigned tasks
caters to the diverse learning modes of students, and allowed them to employ their respective strengths in accomplishing the various tasks.

To foster a good learning experience, the ability to master new knowledge and skills and to critically examine assumptions and beliefs and to engage in a collaborative quest for wisdom and personal holistic development are essential (Eastmond & Ziegahn, 1995). As the students were asked to look for phenomena and think of a final product to present, students had to work with their prior knowledge and assumptions and assimilate the new information. In Eastmond & Ziegahn’s paper, this method of learning is considered a good learning experience for the students. They had to work in groups and therefore there was a mix of prior knowledge and assumptions. This mix of prior knowledge and assumptions would allow students to engage in a collaborative quest for understanding and learning together and from one another.

The use of Instagram in the beginning of the ATT provides an online platform for students to participate in distance learning with their peers, leveraging on technology to facilitate learning outside curriculum time. It provides a collaborative platform for students and their peers to engage in conversations rather than rely on the teacher to provide information, reducing the dependency on the teacher for knowledge. (Elizabeth, Judith, & Price, 1993)

Through this project, students had the opportunity to extend their learning beyond the classroom by embarking on a learning contract with the teacher. Students took the responsibility of choosing their own topic and setting their own goals and timeline; they were guided in self-evaluation and self-monitoring through the use of rubrics and logbooks.
Methodology

Activities

In the beginning of the project, students were grouped into groups of 4 or 5 with each class having 5 groups. There were a total of 4 phases to the end of the ATT as seen in the flowchart shown in Figure 20. In between the start of the ATT to the end of the ATT, there were Mini Transfer Tasks (MTT). These MTT were put in place so as to guide the students as they gain knowledge and ideas to complete the key complex task which is the ATT. MTT such as the posting of a photo depicting a scientific phenomenon on Instagram, commenting on their peer's Instagram posts and recording of reflections and entries in logbooks were put in place to allow them to be more critical of their work and in the end create an end product which has been well thought out.

At the end of the ATT, students are required to present their poster and prototype. The students were told to create an exhibit that can be displayed in the Science Centre to teach science creatively to people with limited scientific knowledge such as kids. The exhibit should display at least 2 Physics concepts that could be taken from the core syllabus of the Physics module or anything that is out of the core syllabus. This gives students the flexibility of selecting the topics that they would want to focus on. Students are also differentiated as there are no specific topics given to them, students can choose to embark on topics that are familiar to them or topics that are challenging. The whole process of the 4 phases is modelled after a scientific process: Scientists must simultaneously traverse between the theoretical model (abstract physics concepts) and the real world (observations, measurements, explain phenomena) to make logical and reasonable conclusions.
First Phase: Science Centre Visit/Fieldwork

In the first phase, students were required to visit either Singapore Science Centre or go around Singapore to find phenomena that are related to Physics. This is required so as to get students to do some fieldwork to understand what they are expected to produce at the end of the ATT. Being exposed to various phenomena allows for ideas generation. Students have to sensitize themselves towards activities or objects in daily life that uses Physics. This is in line with Vygotsky's theory of social constructivism, where abstract concepts and real world experiences must go hand in hand. Real world experiences are necessary to provide a meaningful backdrop where scientific concepts can be applied, challenged and absorbed. At the same time, scientific concepts are necessary to provide a framework and systems of meaning for students to appreciate and make sense of the world around them. This project allows students to recognize and apply Physics concepts to everyday life. This helps them appreciate that scientific models can be deployed to a wide range of contexts in the world around them. As the students had to go around together to look for different phenomena, it provides an environment for the student to participate in collaborative learning as they build on one another's ideas and preconceptions.
Second Phase: Instagram Posting and Commenting

The second phase requires the student to take a picture or Instagram-video of the phenomenon that they have chosen and post it onto Instagram. Explanation of the phenomenon was required to be written in the description portion of the picture posted in Instagram. Students were then required to hashtag the picture or Instagram-video with the word njcphysics so as to get the rest of the students from other classes and their own class to comment or ask questions about the phenomenon. Instagram was used as a platform for discussion and collaboration as it is a popular online social media tool. Since most students have Instagram and have the knowledge of using Instagram, it was easy for them to "like" and discuss about the picture online. The fact that they are not physically discussing about the topic allows for those students who tend to be quiet in class to speak up in the social media platform. This fosters online collaborative sharing and students can learn from one another.

To emphasize on scientific communication, students were given a Socratic questioning sheet to guide them in asking good questions instead of a question that requires a yes or no answer. Ground rules were set up so as to ensure that the sharing takes place in a safe environment without putting down one another's work. Teachers would go online to track the sharing online, question and make comments that further encourage discussion among the students.

Third Phase: Logbook

A logbook was required from every group to log down roles in the project, their progress and thinking process. This is an important process as it allows the teachers to track their learning and for the students to take responsibility of their own progress. Having a logbook that requires the roles of the students to be written down allows the teacher to
prevent the “free rider” problem. There were guidelines given to the students so as to guide the students as they are doing their planning in their logbook. An example would be for them to write down the 2 Physics concepts that they intend to use while building their prototype. Students were told to have at least 2 meet-ups with their teachers to discuss the feasibility of their projects and further improve on their projects after each meet-up.

Scientific communication of what has been done is also emphasized here as the students need to present their logbooks in a clear and creative manner that allows readers to understand what has been done and improved throughout the whole process. Teachers would grade the logbook according to the requirements stated in the rubrics.

**Phase 4: Poster, Presentation, Prototype**

To collect evidences of learning as mentioned in the UbD framework, a poster presentation along with a prototype is required of the students at the end of the yearlong project. Students were assessed based on a rubric to determine their ability to communicate the scientific ideas that they used in their ATT to their peers.

In phase 4, the communication was through 3 different methods.

**Poster**

The students had to prepare a clear and concise poster that communicates the knowledge and concepts to people without scientific knowledge. This challenges their creativity and ability to break down information. Through this they would learn that Physics is understandable when communicated clearly.
**Presentation**

The students have to present both their poster and prototype to their friends and teacher in their groups. The purpose of this presentation was to get the students to learn how to present their thoughts and scientific knowledge clearly verbally. During the lesson that they were supposed to present their poster and prototype, the teacher who is grading based on a rubric would walk from group to group. The rest of the students were to go around “Carnival style” to look at their peers presentation and prototypes while writing down comments and what they have learnt from their peers on a reflection sheet.

**Prototype**

The students were expected to produce a prototype that could display 2 different Physics concepts creatively. Students were graded according to their creativity and workmanship of their prototype. If the prototype could be operated easily by visitors of their booth, they would be able to score a higher mark based on the rubrics. This hands-on approach for the students to build a prototype allows students to do something that is out of the usual curriculum of theoretical knowledge. Instead of just learning the theory behind Physics, they are able to put it in action though the presentation of their prototype.

Bonus marks were given for groups who used recycled materials creatively. This was done to encourage students to recycle objects instead of spending too much money on the construction of the prototype.
Participants

The 185 participants were Grade 9 Physics Integrated Programme students from National Junior College. This project is part of their graded alternative assessment in their Physics module. These students who were selected for Integrated Programme are academically strong and the Integrated Programme provides an integrated Secondary and Junior College education for students Grade 7 to Grade 12. Grade 10 students do not need to undergo the GCE O Level Examination and can proceed directly to Grade 11. (Ministry of Education, 2012)

Analysis and Evaluation

Students were given an online survey to complete which was done at the end of the ATT. The mean scores and standard deviation for each item were calculated at the end of the survey.

End of ATT survey

This survey consists of 9 questions. This survey was rated based on a 4-point Likert scale with a range of 1 – strongly agree to 4 – strongly disagree and a comments section. The questions targeted students’ engagement throughout the different processes: poster, presentation, and prototype. The students rated based on their improvement of their understanding for Physics phenomenon based on doing their group work or visiting the group presentations, passion for Physics and collaboration.
End of AIT survey

139 students' data was used for this study. 184 students participated in the programme and 45 student’s data cannot be computed due to missing information. The mean score of all the items was 3.18 with scores ranging from a minimum of 3.00 to a maximum of 3.27. This indicates a high level of satisfaction based on the results.

The survey results based on the different categories are as follows:

Perception of Engagement Level : 3.21  
Perception of Collaboration: 3.23  
Perception of Understanding of Physics: 3.25  
Perception of Passion for Physics: 3.05  

The results are shown in Table 4.
Table 4: Students Perception of their Physics ATT

<table>
<thead>
<tr>
<th>Question Categories</th>
<th>Questions</th>
<th>SA</th>
<th>A</th>
<th>D</th>
<th>SD</th>
<th>Mean</th>
<th>Categorical Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement Level</td>
<td>I am actively engaged in creating the prototype.</td>
<td>53 (38.1%)</td>
<td>63 (45.3%)</td>
<td>22 (15.8%)</td>
<td>1 (0.7%)</td>
<td>3.21</td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>I am actively involved in the poster making process.</td>
<td>44 (31.6%)</td>
<td>77 (55.4%)</td>
<td>15 (10.8%)</td>
<td>3 (2.16%)</td>
<td>3.17</td>
<td>3.21</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>I am actively involved in the presentation process.</td>
<td>54 (38.8%)</td>
<td>65 (46.8%)</td>
<td>18 (12.9%)</td>
<td>2 (1.44%)</td>
<td>3.23</td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>My teammates are actively engaged during the ATT process.</td>
<td>50 (36.0%)</td>
<td>70 (50.4%)</td>
<td>18 (12.9%)</td>
<td>1 (0.72%)</td>
<td>3.22</td>
<td></td>
<td>0.69</td>
</tr>
<tr>
<td>Collaboration</td>
<td>My team worked well together.</td>
<td>54 (38.8%)</td>
<td>65 (46.8%)</td>
<td>18 (12.9%)</td>
<td>2 (1.44%)</td>
<td>3.23</td>
<td>3.23</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>The ATT has helped me increase my understanding of Physics phenomena.</td>
<td>52 (37.4%)</td>
<td>75 (54.0%)</td>
<td>10 (7.19%)</td>
<td>2 (1.44%)</td>
<td>3.27</td>
<td></td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>The group presentations have helped me increase my understanding of Physics phenomena.</td>
<td>51 (36.7%)</td>
<td>73 (52.5%)</td>
<td>10 (7.19%)</td>
<td>5 (3.60%)</td>
<td>3.22</td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td>Understanding of Physics</td>
<td>The ATT helps me improve my love for Physics.</td>
<td>34 (24.5%)</td>
<td>74 (53.2%)</td>
<td>28 (20.1%)</td>
<td>3 (2.16%)</td>
<td>3.00</td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>I enjoyed myself in the process of doing the ATT.</td>
<td>47 (33.8%)</td>
<td>65 (46.8%)</td>
<td>20 (14.4%)</td>
<td>7 (5.03%)</td>
<td>3.09</td>
<td></td>
<td>0.82</td>
</tr>
</tbody>
</table>

Comments by students

Out of 22 comments made by students, 18 students found the ATT fun and engaging and that it gives them the freedom of choice in terms of choosing the concepts that they would like to use for their ATT.

Teachers' Observations

Students were seen taking the initiative to question the world around them as they would approach their teachers after class to discuss about their ideas. The students were
observed to have done prior research before meeting the teachers to clarify concepts behind the phenomenon.

**Discussion**

From the data collected, there is a general incline towards strongly agree for all categories.

**Engagement Level**

Engagement level of the students has a mean of 3.21 with an average of 85.6% of students agreeing which indicates that the students were participating actively from the beginning of the ATT to the end of the ATT. This result is favorable as the aim of this research was to see if our approach of using an ATT as an alternative assessment would improve the engagement level of students. This is further supported with the qualitative comments given by 18 of the students. The reason of this high engagement level might be due to the different modes of assessment provided for them. This ATT has multiple products; students with different strength can showcase their strength in at least one part of the ATT. When the students were able to identify with a part that they are good at, it raises their self-esteem and motivation. Therefore they are more engaged. This is in line with Howard Gardner’s Multiple Intelligence theory where individuals differ in strength and students being able to invoke the different types of intelligences to carry out the different tasks to solve the different parts of the ATT.

**Passion for Physics**

Most students reported an increase in their passion for Physics learning. The mean score for this is 3.05 with an average of 79.2% of students agreeing. Although it is not as high as the rest of the categories, the results still showed that most students agreed that their love
for Physics has increased and they enjoyed the ATT. This is further supported by the 18 out of 22 qualitative comments by students, which showed that the students liked the ATT and felt that this ATT should be carried out next year for the Grade 9 students.

**Collaboration**

From the data, with a mean of 3.23, standard deviation of 0.73, with 85.6% of students agreeing, it can be seen that students put in their best effort in their group to complete the task implying that the students were actively participating collaborating in their groups. This would also mean that there are not many free riders in the groups. This reason for this might be the enforcement of personal accountability through the definition of roles in the logbook. The students who tend to not do much work in groups might feel the need to contribute more due to this component in the logbook as the teachers would be able to track students who are not doing their work.

**Conceptual Understanding**

An average of 90.3% of the students perceived the ATT tasks beneficial to their understanding of Physics phenomena, evident from the high categorical mean of 3.25. This is in line with Vygotsky’ views in Thought and Language (Vygotsky, 1986) where he said that analysis of reality with the help of concepts precedes analysis of the concepts themselves. Allowing students to look at both the reality and use the concepts to explain phenomenon in reality further strengthens their ability to understand the concepts that are brought out.

Through the observations of the different products that the students have produced, we are also able to observe different evidences of creative and clear scientific communication and conceptual depth differences in the different products. As the ATT is differentiated by products and is an open ended task, different groups were able to demonstrate various depth
of conceptual understanding. There were groups who showed understand beyond that of a Grade 9 student. An example would be a group who used beer bottles to apply the concepts of standing wave and resonance effect. The prototype can be seen in Diagram 2. They were able to explain the underlying concepts during their presentation. Self-directedness of the students could be seen as they went beyond the syllabus and took charge of their own learning. The ATT provided room for them to self-explore concepts that linked to the real world. Having this knowledge, when they are exposed to theories that would be taught in Grade 10 and above they would be able to link the real world scenarios to the concepts that they are learning. This would further strengthen the concepts that are being taught.

**Scientific Communication**

Different groups had different methods of presenting their project. There was a group who utilized their strength in acting and integrated their presentation with a storyline. They were able to come up with a creative storyline to communicate the concept on hydraulics to their audience. Their prototype construction was average but their presentation skills were good. This is an example of students being able to communicate their scientific ideas effectively through various means. Diagram 1 of this prototype is appended at the end of the document.

**Areas of Improvement**

Some areas of improvement would be to provide more scaffolding for the initial stages of the ATT, some groups found it hard to include 2 Physics concepts into their prototype. Teachers could have provided more examples of Physics phenomenon. As this is the first time we are trying out this ATT, the prototypes of the students this year could be shown to the Grade 9 students next year so as to show them some examples of what is expected of them. Some examples of other prototype have been added to the appendix.
Conclusion

In conclusion, it is shown from results that there is an average of 85.6% agreeing that they were engaged and collaborated well when they were doing their ATT. 90.3% of students improved their understanding of Physics and 79.2% of students increased their passion for Physics after completing their ATT. From the results, we were able to achieve an increase in the students’ conceptual understanding of Physics and passion for Physics which was the aim of this research. This ATT would be further improved on and brought to the next year as an alternative assessment for the Grade 9 students.

References


Appendix

Diagram 1: Hydraulics Prototype

Diagram 2: Beer Bottle Resonance