INFUSING 21st CENTURY COMPETENCIES INTO THE CURRICULUM: A SCHOOL-LEVEL, MULTI-DISCIPLINARY PERSPECTIVE

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ABSTRACT

This study sharing the findings of a school-wide approach to infusing 21st Century Competencies into various subjects in the Instructional Program. Each team of teachers designed its own action research study to investigate questions that were relevant and meaningful for their respective content area.

Through these studies, a cross-study analysis was conducted to explore how innovative teaching could support students in developing 21st Century Competencies. At the same time the ways in which pedagogical approaches such as inquiry-based learning and place-based learning support innovative teaching was also investigated.

Through this analysis, it was found that innovative lessons do provide students with meaningful opportunities to develop 21st Century Competencies. Both students and teachers also reported that innovative teaching methods had resulted in lessons being more student-driven and students were motivated to find out more about the subject area.

Keywords: 21st Century Competencies, Educational Research, Student Assessment, Pedagogy, Innovative teaching.

1. INTRODUCTION

21st century competencies that prepare students for their future work environment are becoming increasingly important. These competencies include problem solving, collaboration and knowledge construction skills. (MOE, (2015), Ananiadou and Claro (2009)). There are many different pedagogical approaches and lessons that could target different 21st century competencies. However some subjects are better suited to develop certain competencies.

Five subjects were studied over a time period of eight months, which used different pedagogical approaches and technology tools to infuse the development of these competencies into the curriculum. These approaches included flipped learning (Chemistry), inquiry-based learning (Biology), collaborative learning (Character and Citizenship Education), mathematical modelling (Mathematics) and Place-Based Learning (English). The technology tools employed by the five subject areas included online collaborative platforms, video conferencing and a technology application that supports Place-Based Learning and learning trails. To determine the holistic impact of these pedagogical approaches on developing the competencies in our students, common data collection tools were used for all the projects. These included assessment of students' competencies using student assessment rubrics, focused group discussions for both teachers and students and student surveys.

2. METHODOLOGY

Participants

Participants consisted of 13 to 15 year old students. Depending on the project and resources available, the participants for each project ranged from two classes (total of 80 students) to the entire level of students (more than 200 students).

Data Collection

Common qualitative and quantitative data was collected for all projects. The data collected include:

1) Pre and post student survey. A student survey was conducted for the students before and after the lessons that employed the various pedagogical approaches and technology tools. This would provide a general sense of the students' perceptions towards the different pedagogical lessons infused with opportunities to develop 21st century competencies. For example, the Mathematics teachers conducted a survey to ask

students about their perception of the value of Mathematics in the real world.

2) Pre and post content test. A content assessment was given to the students before and after the various lessons. Both the Chemistry and Biology project conducted an assessment on the respective subject concepts before and after the intervention.

3) 21st century competency rubrics scores. The Students' Assessment Rubrics were jointly developed by Crescent Girls' School and Stanford Research Institute, International. There are five dimensions of 21st century competencies, namely Collaboration, Real-World Problem Solving, Knowledge Construction, Skilled Communication and Global Awareness. Students' work was scored using the relevant rubrics and awarded one of the three levels of approaching, meeting or exceeding expectations.

4) Classroom Observations. Teachers teaching the same subject and level observed each other' classes using a structured classroom observation protocol. This provided information about the implementation of the various pedagogies in the classrooms.

5) Student focus group. Teachers facilitated a focus group discussion with students after the various lessons. The discussions served to elicit students' perspectives on their experiences with the various pedagogies.

6) Teacher focus group. The school's research committee facilitated the teachers' focus group discussion with the teachers involved in the project. This provided the teachers' perspective on the various lessons as well as the teachers' experience in planning and implementing the various lessons.

Data Analysis

Common qualitative and quantitative data was collected for all projects. Focused group discussions, open-ended student surveys and classroom observations were coded for qualitative analysis.

For quantitative data, students' scores on 21st century competencies, content assessments and Likert Scale student surveys were collected. Using these data, descriptive statistics were obtained to identify descriptive differences between pre and post intervention as well as between control and treatment groups whenever possible.

3. RESULTS AND DISCUSSION

For the Chemistry project, the content pre-test scores are 57.5% and 58.9% for the control and treatment group respectively. In the post-test, the scores are 86.1% and 88.2%. There was a slight increase of 0.5% in the test score difference between the control and treatment groups of students.

There was no significant difference between the control and treatment groups of students' assessment rubrics scores. Both groups of students achieved meeting expectations levels on average. Out of a maximum score of 6.00, both groups of students scored lower on the two strands of Ability to Interpret and Infer (2.88) and Analysis (3.08). They fared better on the Synthesis strand with a score of 4.37 on Complexity of Synthesis and 3.42 for Quality of synthesis.

From the students' focused group discussion, some students indicated that they preferred flipped learning as they felt that there was more thinking involved and there were more opportunities to apply knowledge. Other students preferred the more traditional didactic teaching, where they listened to the teacher and took down notes. This corroborated with the students' post intervention survey where both groups of students indicated neutral to slight agreement that they would prefer doing a science experiment compared to learning about Science from teachers. The inquiry approach of learning through experiments requires students to take responsibility for their learning and this may not be a preferred learning approach of some students.

For the Biology project, some students reported during the focused group discussion that inquiry-approach may be more effective for some students than others. Positive responses from students include being motivated to learn more and being interested to find out more about the lesson materials. With more time and exposure to this approach, possibly more students would find this approach more motivating.

From the Knowledge Construction student assessment rubrics, the treatment group have a higher overall score of 3.01 compared to 2.40 for the control group. There was a statistically significant positive different between treatment and control group on the Ability to Interpret and Infer (p-value = 0.0459), Ability to Analyze (p-value = 0.0200) and Quality of Synthesis (p-value: 0.0259). The results indicated that lessons the treatment group attended helped them to develop Knowledge Construction skills as compared to their peers.

For the Place-Based Learning project, there was a 10% increase in the number of students who felt emotionally connected to the poem after visiting the venue where the poem is based. 98% of these students reported that knowing what happened at the venue helped them better understand the poem. During the focused group discussion, a student highlighted that at the venue, she could verify her thoughts with the information and artifacts there. These supported her interpretation of the poem. Another student described herself as being more independent in learning. She needed to look around at the venue for answers instead of letting the teacher spoon-feed her with information.

Using the Knowledge Construction rubrics, students achieved meeting expectations for Synthesis and Interpretation strands. Students scored lower on the Analysis strand, on average achieving the approaching expectation level. These results seem to indicate that the learning activity was better aligned to building Interpretation and Synthesis skills than Analysis skills.

Using the Collaboration rubrics, students were achieving meeting expectations or higher levels for Cooperation, Individual Accountability and Leadership. These suggested that most students have good collaborative skills and are able to work together in a group.

For Mathematics, students did a pre and post-test survey about the value of Mathematics in the real world. After the math modelling lesson there was a slight drop in the number of students who strongly agree with many of the survey statements. Some of these survey statements include "I want to develop my mathematical skills" and "I can think of many ways that I use mathematics outside of school". A possible reason for this decrease could be due to the modelling scenarios given to the students. While these scenarios are realistic and possible, students may not view them as authentic problems experienced by people in the real world.

Using the Real-World Problem Solving rubrics, on average there was improvement in the students' score from the formative to the summative assessment for Definition, Research, Feasibility and Diversity of Ideas. However, there are also classes which showed a decrease in scores. This could be due to a more demanding summative assessment or higher teacher expectations for these classes. As there are different teachers assessing different classes for these assessments, there may be a need to calibrate the application of the assessment rubrics by the teachers.

For the collaborative learning project most students rated their peers at meeting expectations or higher using the Collaboration rubrics. This suggests that most students are strong in working together in a team. However through the focus group discussion, a student shared that she gave her peer a meeting expectation grade even though her peer did not do her work. She felt bad giving her a bad grade.

Across the projects, students were making progress on Knowledge Construction and Real-World Problem Solving dimensions. In Biology, there was a statistically significant difference between control and treatment group students in three out of five strands in the Knowledge Construction rubrics. In Mathematics, students showed improvement on Real-World Problem Solving dimension.

Students were exceeding expectations in Collaboration competencies. In both English and Character and Citizenship Education, students thought that their peers were meeting or exceeding expectations in working together.

Content learning in Biology and Chemistry were comparable between control and treatment groups using innovative pedagogies to infuse 21st century competencies. For both subjects, students' content assessment scores showed improvement when comparing the post to the pre intervention scores. Even with a shift lesson in focus from content to skills building, students undergoing intervention had the same learning as the control group.

4. CONCLUSIONS

The qualitative data showed that students have become more proficient in many of the 21st century competency dimensions and strands. At the same time there were positive changes in the classroom dynamics. Both students and teachers reported that innovative teaching methods had resulted in lessons being more student-driven with more opportunities to build 21st century competencies. This finding is consistent with that of Chu, Tse, Chow (2011), who reported that collaborative and inquiry based lessons allows students to develop critical thinking skills and requires them to be more self-directed learners.

The shift in the responsibility of learning from teacher-driven to student-driven provided more opportunities for students to develop skills in areas such as knowledge construction and collaboration. Students were more motivated to learn concepts in the Biology inquiry-based lessons. Other students in the English class developed processes to direct their own learning. A student gave feedback that she was able to learn and discover on her own, rather than learning information directly from the teacher.

Innovative pedagogical approaches often targeted multiple 21st century competencies. The English lesson required students to develop knowledge construction skills by interpreting a poem and to practice collaboration skills by co-creating a new poem with a peer. Students in the Mathematical modelling lesson used problem solving skills to design innovative solutions within the constraints of the problem. While working on the problem, they had to engage in collaboration skills such as negotiation and offering quality contributions.

With students being more self-directed and given more opportunities to practice and develop the various 21st century competencies during lessons, most students become more proficient in them.

These results show a high level analysis of the impact of the school-wide approach to development of 21st century competencies. While individual projects present variations in interventions, technology tools and student experiences, the data shows that students' proficiency in the 21st century competencies has increased. Hence, a coordinated school-wide approach that presents students with a myriad of opportunities to develop all the competencies across different subjects has reaped holistic impact on student proficiency and skill acquisition. A longitudinal study of the developmental progression in student proficiency across the four years in the school would yield further data on school-level impact and levers for greater effectiveness.

5. REFERENCES

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