e-Learning in Level 1-3 Physics Investigations

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Introduction

Gisborne Boys' High School serves a predominantly indigenous community in a poorer area of New Zealand (socioeconomic decile 3, n = 920, Maori = 68 %). In 2015 Boys' High added 300 Chromebooks to their existing 90 desktops. In response, the eight teachers of the Boys' High Science Department developed an **e-learning environment for physics investigations** utilising a variety of free applications. The e-learning environment included:

- Google Classroom (resource sharing and management);
- YouTube (videos reinforcing each concept);
- PhET (game-like simulations of physical phenomena);
- Google Forms (self-marking multi-choice questions);
- Google Sheets and Plot.ly (data and graphical analysis);
- Google Docs (report writing);
- Google comment features (teacher feedback inserted directly into student work).

Students undertook practice investigations and activities for 4 weeks before a final assessed investigation.

Physics investigations were undertaken at:

- Level 1 (≈ 15 y) – investigating linear relationships
- Level 2 (≈ 16 y) – investigating non-linear relationships
- Level 3 (≈ 17 y) – investigating non-linear relationships including a consideration of uncertainties.

Methodology-Analysis Framework

The e-learning environment was introduced into two contexts and thus allows two forms of evaluation:

- Selective **Physics courses** with a history of physics investigations compare the e-learning environment (2015-2016) with traditional methods (pen, paper and calculator or Microsoft Word and Excel were used in 2013-2014).
- Non-selective **General Science courses**, which had not previously undertaken physics investigations, compare the e-learning environment (2015-2016) with all the other internally-assessed topics in that course (2013-2016).

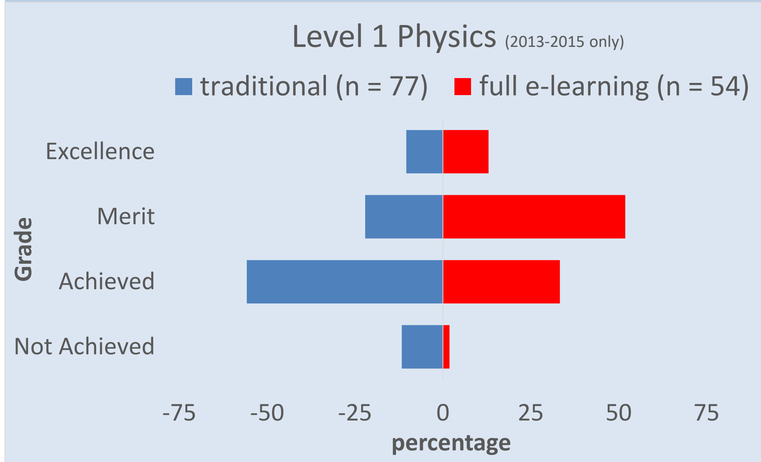
New Zealand uses *standards-based* assessment with outcomes of *Not Submitted, Not Achieved, Achieved, Merit* or *Excellence*. Coded 1-5, the ordinal grade distributions for the final assessment of each standard were evaluated using SPSS crosstabs and the Linear-by-Linear Association Chi-Square test, $L\chi^2$, for significance with Pearson's r for strength of correlation.

Research Question

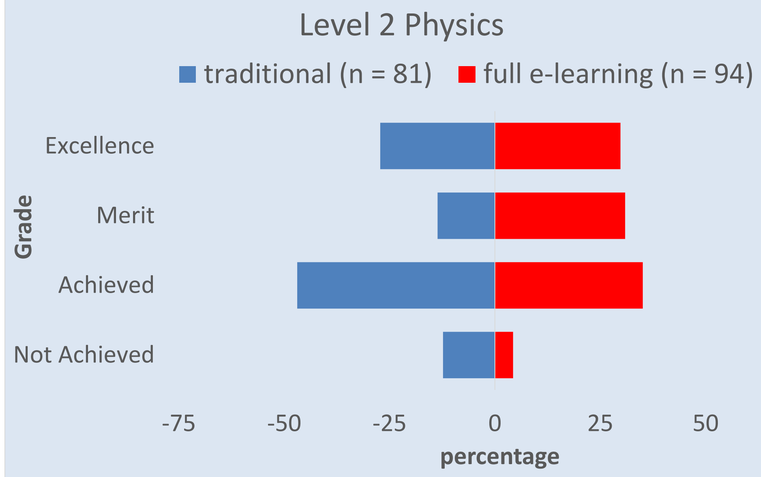
Has the e-learning environment for physics investigations enhanced student outcomes?

Results

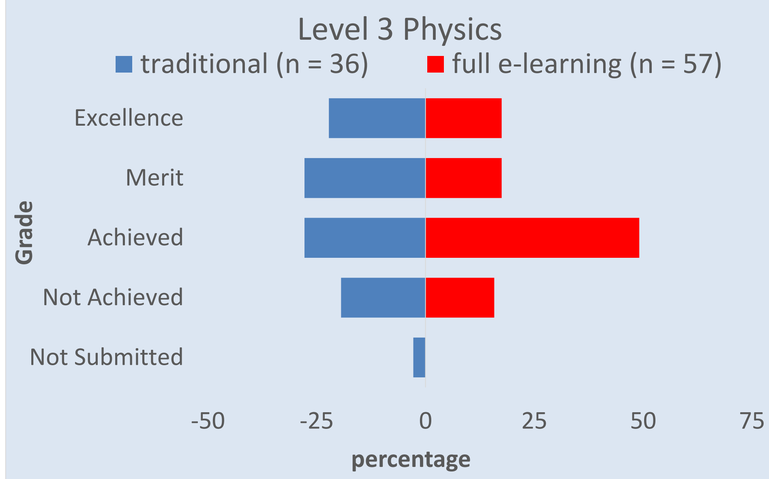
Physics courses
traditional methods vs the full e-learning environment



$L\chi^2$ (1) = 9.989 p = 0.02, r = 0.277 p = 0.001

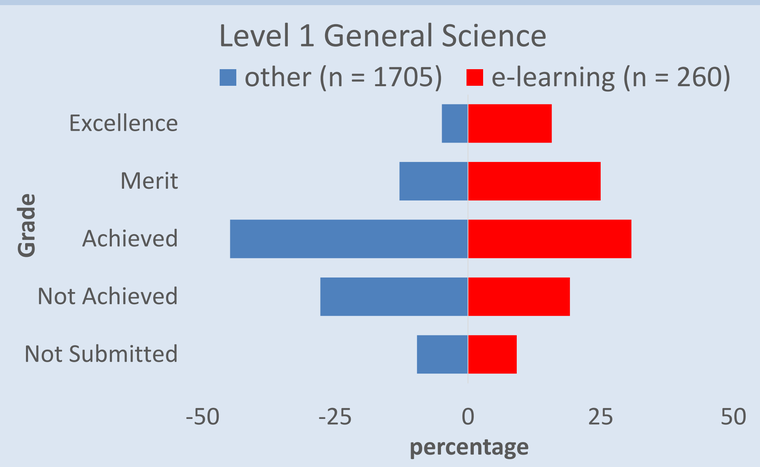


$L\chi^2$ (1) = 4.346 p = 0.037, r = 0.158 p = 0.037

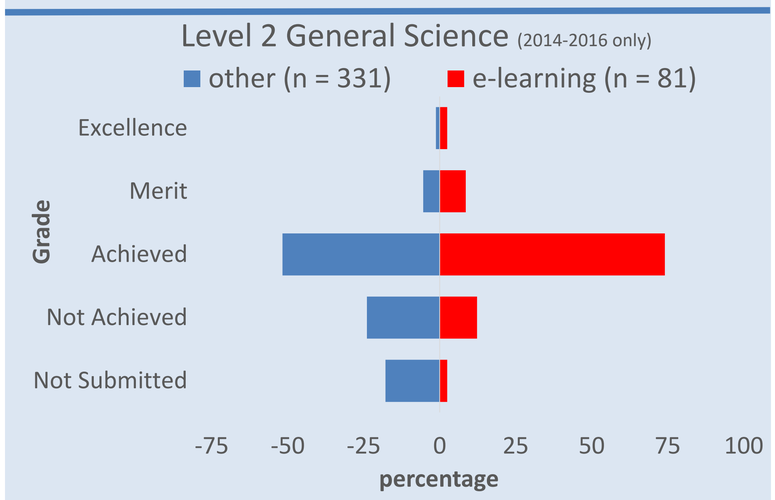


$L\chi^2$ (1) = -0.476[stzd] p = 0.355

General Science courses
all other topics vs the e-learning physics investigation



$L\chi^2$ (1) = 41.67 p < 0.001, r = 0.146 p < 0.001



$L\chi^2$ (1) = 4.465[stzd] p < 0.001, r = 0.220 p < 0.001

Results Summary

- Level 1 and 2 Physics students gained significantly better grades for physics investigations when in a <u>full</u> e-learning environment than when using traditional methods.
- Level 3 Physics – no significant differences but a notable peak at Achievement.
- Level 1 and 2 General Science students gained significantly better grades in the e-learning physics investigations than in any other internally assessed topics.

Conclusions and implications

The e-learning environment for physics investigations has enhanced student outcomes.

- Previously judged beyond many students, the e-learning environment places physics investigations within the reach of the majority by:
  - improving engagement and organisation;
  - modelling and isolating analytical skills;
  - improving the quality and rate of analysis and thus increasing the time available for critical thinking;
- Students produce better physics investigations when e-learning moves beyond data analysis and word-processing and includes mechanisms that facilitate student-teacher dialogue.
  - These gains are evident until the data analysis apps challenge the students as much as the physics.

It is hypothesised that the e-learning environment can be usefully extended to other areas of high school science. This project is underway and will be evaluated in January 2018.

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