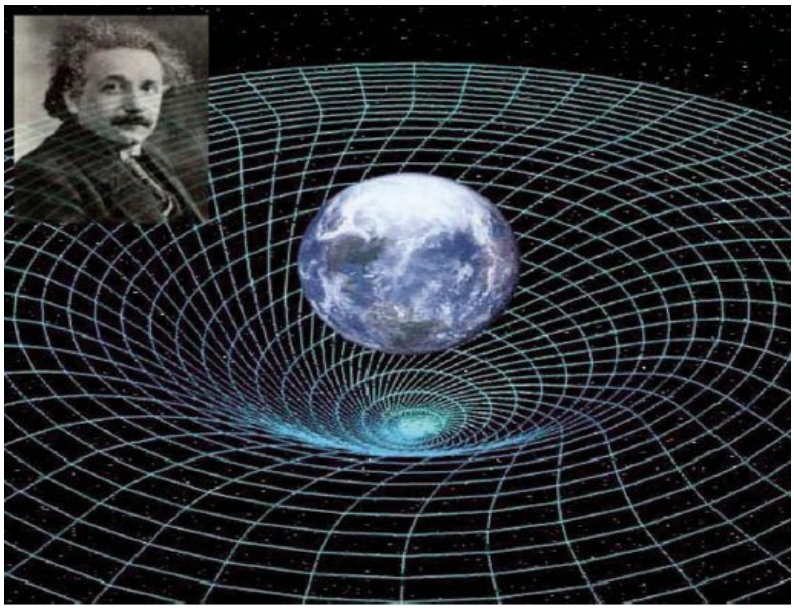
THE UNIVERSITY OF WESTERN AUSTRALIA



Feedback: Integrating Einsteinian Physics and Mathematics into the Year 3 to Year 10 Curriculum

Workshop details

Title: Integrating Einsteinian Physics and Mathematics into the Year 3 to Year 10 Curriculum

Date and time: Monday 28 June 2019 from 8.30am to 3.45pm

Venue: University of Western Australia

Participating schools: Total schools 28

13 primary, 1 district high and 14 senior high.

1. Introduction

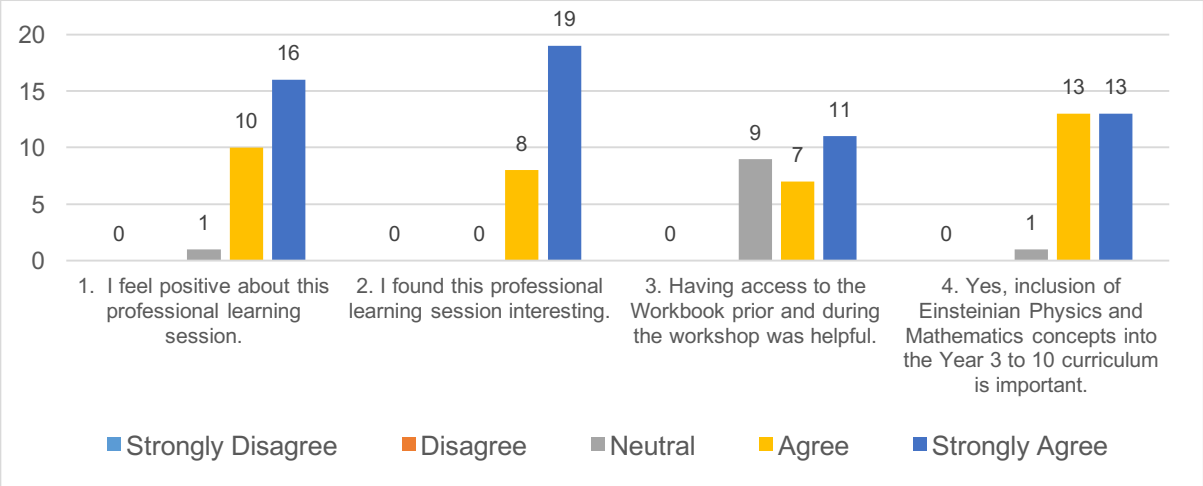
We would like to thank participants for their feedback. We received 27 responses; a very pleasing 96% response rate. Only feedback from school participants has been included.

Reaction to the professional learning

Overall reaction

Feedback from participants was generally positive overall, with all respondents indicating they either 'agree' or 'strongly agree' they *found the professional learning session interesting* and 96% indicated they 'agree' or 'strongly agree' with the statements that they *felt positive about this professional learning session* and *yes. Inclusion of Einsteinian Physics and Mathematics concepts into the Year 3 to 10 curriculum is important*. Only 67% of respondents either 'agree' or 'strongly agree' with the statement that *having access to the Workbook prior to the workshop was helpful*.

Figure 1: Frequency of responses to questions relating to participant's overall reaction to the professional learning (n=27)



In response to the open-ended Question 5: *What was the best feature of this professional learning session?* thirty four discrete ideas were provided. These were categorised, with the number in each category shown in brackets. The four categories are:

- more hands-on activities with opportunities to discuss concepts being illustrated (18 comments)
- networking with colleagues and the Einstein First team (8 comments)
- learning new concepts (4 comments)
- improving the curriculum for students (4 comments)

All comments sorted into these four categories and provided in Attachment 1.

When asked about improvements that could be made, twenty-two (22) responses were provided to the open ended Question 6: *What one feature of the professional learning session would you change to improve it?* All comments are listed in Attachment 2. Responses were not as clear-cut to categorise except for:

- need more time (6 comments)
- need to use more accessible language and where appropriate, explain the relevance and application of concepts (5 comments)
- when explaining ideas, presenters should consider explanations and demonstrations from a student's perspective (3 comments)
- only present concepts relevant to Primary school level (2 comments)

In addition, there are six separate suggestions:

- mapping against Western Australian/Australian curriculum. It is not done seamlessly at the moment
- need resources to be developed for the transition
- presenters should have a better understanding of what happens in the classroom
- more explanation about waviness and bulletiness
- examples of questioning – inquiry skills – i.e. predicting, observing, explaining why
- provide more variety of food – don't normally eat bread

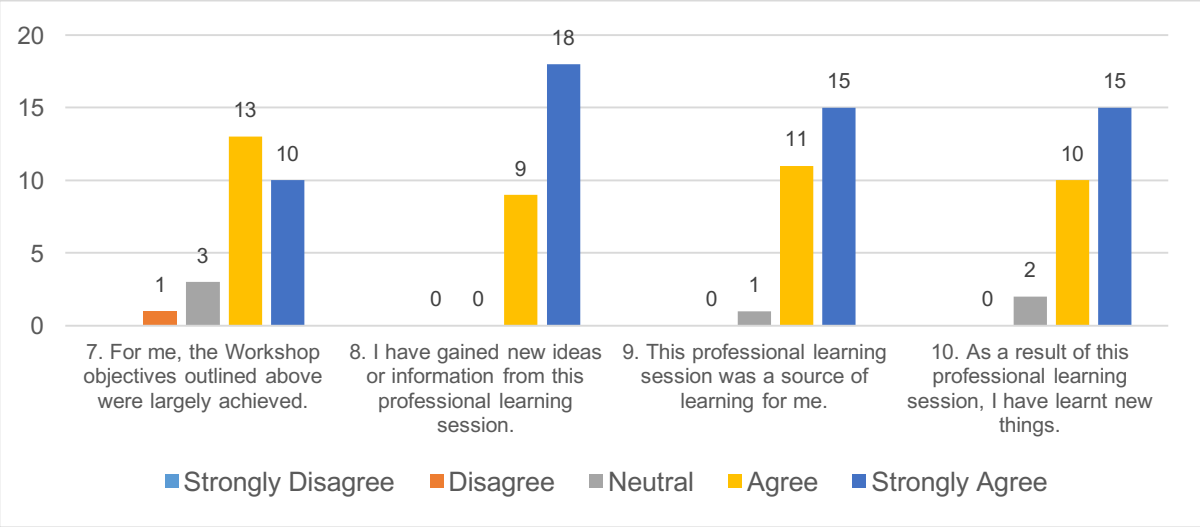
Learning

The workshop objectives were to:

- introduce the Einstein-First project
- propose a 'draft' Einsteinian science curriculum as a starting point for the project
- obtain participants' advice regarding the proposed learning sequences
- seek support and commitment to be part of this research venture.

Overall, 85% of participants either 'agreed' or 'strongly agreed' that the workshop objectives were achieved. All participants (100%) indicated that they learnt new things or information from this professional learning; 96% indicated the professional learning session was a source learning for them and 93% indicated that they have learnt new things.

Figure 2: Frequency of responses to questions relating to your personal learning resulting from participation in the professional learning (*n*=27).



Ongoing participation in the Einstein First initiative

Participants were asked whether after attending the workshop, they are still keen to stay connected with the Einstein First Initiative with the view to participate in the research. All who responded to the survey indicated yes, with several respondents indicating they are looking forward to the initiative.

Advice on how to prepare teachers so they feel confident with the new content and how to teach it

The final evaluation question asked participants the following:

> *Given that the longer term goal of the Einstein First initiative is to integrate Einsteinian physics into the existing primary and secondary school science curriculum, what advice would you give to the project team about how to prepare teachers so they feel confident with the new content and how to teach it?*

Both primary and secondary teachers provided detailed responses which have been categorised and presented below. The Einstein First team is very grateful to receive such detailed, practical advice and will consider it carefully in planning the research initiative, particularly, how the team should interact with participating teachers individually in their schools, and but also as a whole group.

Categorised responses are outlined below:

Primary teacher advice

Suitable programs, learning resources and associated support

- Use teachers within the project to develop curriculum – programs, resources, teacher resource banks
- Show them where the content/concepts/experiments fit in the existing curriculum by providing scope and sequence
- Curriculum links provided alongside relevant contents
- Year 5 Physics Curriculum is already loaded, 6 elaborations, Earth & Space is lighter, better to add to
- Access to resources and materials such as lycra sheets and woks, or where to obtain them and how to make them.
- Sample lesson plans/resource banks made available to teachers
- Resource banks and videos – teaching behind it.
- The activities need to be piloted by a few teachers and then these teachers presenting it to others as a teaching program.
- Provide plenty of background information for the teachers with hands-on activities and explanations of these activities in 'simple' language (for generalist teachers, not teachers with a science background)
- It must be easy to present
- Teachers need to see applications of the concepts so lesson plans with recordable data should be introduced. Also demonstrate how it gets assessed.
- I teach at a school with onsite IEC and 85% EALD. Therefore, concepts cannot be abstract. Concrete ideas are essential, plus a focus on accessible/simple language
- Offer suggestions on other activities and concepts and a suggested timeline.
- Produce handbooks based on time etc., with correct information in teacher language – we can quickly upskill our knowledge.

Suitable assessments

- Don't assess ideas in primary school
- Provide graded samples of expected level of achievement for assessment.

Content/style/nature of professional learning

- You need teachers on board to help develop this, understand it and deliver it.
- Teachers will require a lot of PD with the concepts so that they are confident with their own understanding of them, therefore offering PD would be essential
- Lots of PD and hands-on experiences for teachers with 'basic language' instruction from the presenters so we the teachers feel better prepared and equipped to teach physics in the classroom
- Professional learning workshops go to the schools if possible – opportunities to have project team come into our schools (classrooms) so we have the opportunity to see in our context. Then get a chance to practise further in our school and they get together to discuss the learning that occurred
- Mentor physics teachers with primary specialists.
- Mentoring, chance to watch others presenting ideas in classrooms.
- Supporting us to present to teachers in schools.

- Create videos and examples of concepts being taught e.g. a video showing a teacher teaching the concepts in Year 2, 3, 4 and 5
- When presenting to teachers, do not assume a science background – no jargons
- Upskilling teachers will be important – not just a day or session – they need to "learn" concepts and how to teach them.
- Further opportunities to get together and discuss the concepts and try activities.
- Have the scientists to teach lessons and talk – integrated.
- Get involved with STEM scientists in schools program.
- Allow every involved teacher to try each investigation.
- It would be great to meet as a group again to develop networking, collaboration and support.

Developmental nature of content knowledge development

- Need to learn the language, so a 'word' bank with child/teacher friendly definitions (glossary)
- Glossary of terminology and examples for primary school.
- Kids need to have prior knowledge before they can build on these new concepts.
- Younger kids learn from doing and not abstract thinking so require resources which will give these.
- Please ensure that the concrete basis and real-world understanding of kids is solid first
- Play-based informal learning is a great idea
- Be open to teachers' understanding of how students learn and the constructivist approach vs concrete – abstract.
- Some concepts are still very abstract and difficult to understand. I think this needs to be really simplified and ensure understanding as teachers need to be confident in this in order to teach it.
- Tell them about how this is different to what we already know and teach.
- Only mandate a few concepts

Link learning to Science as a Human Endeavour and practical applications

- Develop true life stories as a basis for Science as a Human Endeavour – connecting to the science
- Also help to scaffold the learning and assess it.
- Give them real life hook.

Other ideas

- Accept that just because a student 'does' an activity it does not mean they understand it – need teachers who are able to be effective teachers.
- Perhaps schools should ensure that science in primary school is 2hr/week or learning and understanding will be too superficial.

Secondary teacher advice

Suitable learning resources and associated support

- Get a teacher on the Einstein First team to map the ideas of Einsteinian physics against the Australian curriculum. It is not clear at this point of time how these relate.
- Clear guide to where the concept development sequence aligns with the curriculum.

- There needs to be clear terminology and resource links to allow new physics teachers to deliver the curriculum in a meaningful manner where students are enrolled and staff feel confident that they are competent in delivery. If teachers feel comfortable then they are far more willing to engage in different pedagogies (concepts/curriculum).
- Assistance with relevance in curriculum/physics
- Suggested programs and activities for schools to implement into Years 7-10 science programs (scope and sequence) related to WAC
- Professional curriculum advice on exactly where/when this content could be implemented.
- Online repository of resources at laboratory description (equipment list and steps to follow) – video examples – sharing portal
- Resources available to staff/teachers schools – equipment – information – worksheets – suggested activities
- More resources need to be developed to create program. Lessons, assessments and syllabi.
- Produce You Tube videos on how to teach concepts and demonstrate the experiments.
- Make a resource bank online with short videos explaining each resource available.
- Teachers can easily access videos and resources while preparing to teach.
- Ways to scaffold information/content for students – also for teachers – which levels to hit or important points.
- Show how students of all ages understanding and interacting in the activities

Suitable assessments

- Development of suitable assessment tasks appropriate for content
- Assessment, Assessment, Assessment - the most significant question that everything in schools orbit around is assessment. How will we test students? From this comes the minimum curriculum knowledge e.g. terminology, concepts, mathematics. Teachers will need to know what students need to know and be assessed on.

Content/style/nature of professional learning

- More PD about concepts so that the teachers feel confident and competent to teach of their students. (from DHS representative)
- PD for teachers in schools (other staff)
- Teach a mock lesson so teachers can see how the concepts are explained on a basic level – so that low ability students can access the information
- PD sessions for ALL science teachers
- PD sessions for trainee teachers
- PD sessions for beginning teachers
- Regular PL – comprehensive training for non-physics teachers
- PD for non-physics trained science teachers will be crucial; also ongoing support as the project is implemented.
- Mentors to visit schools – regions
- Access to others/mentors to see best practice in teaching and demonstrating ideas and skills.
- Workshop teachers on the ideas and underlying concepts.
- Supporting out of area teachers: modelling – mentoring – coaching

- Please don't forget regional schools! We can't always get to Perth for PD. (Well delivered online PD can work – secondary Pathways (DOE) produce great online PD.)

Support with development of content knowledge

- Link to existing concepts to develop understanding
- Assistance with terminology/subject specific content
- Support for teachers/assistance – help in understandings
- You will REALLY need to define *quanta* and *momentum* and how they can be exemplified. Break these concepts down more and not move too fast.
- Use the language that they will eventually be using in upper school, particle-model and vectors.
- Provide scaffolded content so non-physics teachers are confident
- These concepts appear to only be appropriate for high academic level students. If we're wishing for students to genuinely understand the concepts.
- Do's and don'ts – there is the potential to create misconceptions if not taught correctly.
- You need a teacher to consolidate what outcome you want and what will be translated into a school context.
- There are important cross-curricular opportunities so we need input from Mathematics teacher in particular.

Attachment 1: Question 5 categorised responses: *What was the best feature of this professional learning session?*

Hands on activities with opportunities to discuss concepts being illustrated (18 comments)

- demonstrations using equipment
- doing the practical activities
- getting to view and discuss demonstrations ourselves
- interactive aspect
- new ideas
- better practical and simple demos
- interactive activities
- having demonstrations of learning and teaching resources
- the practical aspect of doing the activities and then being able to link them back to the classroom
- hands on demonstration of concepts
- new ideas for concrete materials to use in the classroom
- opportunity to do hands-on and understand the models which might be used
- hands-on demonstrations and opportunities for discussion
- viewing and participating in activities
- hands on activities with opportunities to discuss and analyse
- resources used for modelling Einsteinian physics concepts
- the hands on activities and the explanation of the physics behind them, how they link to the real world and how it is different to what we already know
- demonstration of concepts

Networking with colleagues and Einstein First team (8 comments)

- networking
- staff discussions with colleagues
- discussion with other science teachers
- sharing of ideas with other teachers
- discussion with other science teachers
- opening dialogue between various parties with different agendas
- discussion and logistics of implementation
- exposure to this new program and chance to discuss with colleagues

Learning new concepts(4 comments)

- was challenging and I learnt and understood new things
- learning new content
- thinking deeper with others about the Einsteinian ideas
- able to ask our guides questions at all levels

Improving the curriculum for students (4 comments)

- more development of the scope and sequence
- opportunities to discuss and give our ideas as practitioners
- improving our current knowledge and curriculum for our students
- handouts making it meaningful for our students

Attachment 2: Question 6: categorised responses: *What one feature of the professional learning session would you change to improve it?*

These were categorised, with the number in each category shown in brackets

Need more time (6 comments)

- more time to look at and discuss curriculum and assessment
- more time to look at the curriculum
- more time and better structure for reflection and planning
- more time – 2 days
- maybe longer discussion time to individual teachers
- longer feedback session – had to speed through

Need to use more accessible language and where appropriate explain relevance and application of concepts (5 comments)

- academic jargon, scares too many people
- not being 'cluey' in physics, I found parts of the session confusing
- more explanation of relevance of some activities
- the delivery was confusing. I have three degrees none of them science. It was beyond my understanding
- more discussion of relevance of some activities

When explain ideas, presenters consider explanations and demonstrations from a student perspective (3 comments)

- teach the activities as if we were the students
- approach the ideas as if we were students to see how you are pitching it
- view these demonstrations from student perspective – how should these demonstrations look and feel for students

Only present concepts relevant to Primary

- only include primary activities (e.g. no lasers)
- session on components only relevant to senior school

Other suggestions

- mapping against Western Australian/Australian curriculum. It is not done seamlessly at the moment
- need resources to be developed for the transition
- presenters have a better understanding of what happens in the classroom
- more explanation about waviness and bulletiness
- maybe examples of questioning – inquiry skills – i.e. predicting observing – explaining – why
- more variety of food – don't normally eat bread

Appendix 1: Workshop outline, objectives and programme

Outline of Workshop

At the workshop, participants will be introduced to our resources which we use to teach the concepts of space, time, gravity and light. In the second stage, we will ask participants for feedback on how we can introduce these concepts at various year levels.

Programme Objectives

Our longer term goal is to integrate Einsteinian physics into the existing primary and secondary school science curriculum and have this taught in all schools across Australia. Your suggestions and comments will be extremely helpful for us to collaboratively design future programs for primary and secondary schools.

The aims of this workshop are to:

- introduce you to the Einstein-First project
- propose a 'draft' Einsteinian science curriculum as a starting point
- obtain your advice regarding the learning sequences we propose
- seek your support and commitment to be part of this very important research venture.

Programme

Time	Content
8.30 – 8.45	Arrival and registration
8.45 – 9.00	Introduction, purpose and process for the day — David Wood
9.00 – 9.30	1. Overview of the Einstein First initiative — David Blair
9.30– 9.45	Overview of activities and outline of familiarisation plan and process
9.45 – 10.45	2. Introduction to Einsteinian Physics learning resources and activities • models and analogies at primary level • models and analogies at secondary level
10.45 – 11.00	Morning tea
11.00 – 12.30	Introduction to Einsteinian Physics learning resources and activities continued
1.30 – 2.30	Lunch
2.30 – 3.00	3. Feedback from teachers for proposed curriculum sequence • Primary teachers — David Wood • Secondary teachers — Elaine Horne
3.00 – 3.15	Workshop reporting and evaluation — David Wood
3.15 – 3.30	Next steps — David Blair and David Wood

Appendix 2: Workshop participants and schools

School representatives

Teacher	School	Teacher	School
Karen Wood	Millen PS	Darren Hamley	Willetton SHS
Rebecca Reiger	Millen PS	Paul Zampogna	Duncraig SHS
Tim Neil	Mel Maria CPS	Russell Trowbridge	Coodanup College
Judith Pescodd	Woodlupine PS	Andrea Vis	Gingin DHS
Mady Colquhoun	Armidale PS	Richard Meagher	Mount Lawley SHS
Linda Townend	Mosman PS	Garry Foster	Guildford GS
Alison Gullick	Dianella PS	Ben Garnaut	Warwick SHS
Jenny Jones	Madeley PS	Jakob Brooks	Carine SHS
Silvia Varrone	St Peter's CPS	Heather Valentine	St Georges AGS
Jennifer Warden	Pearsall PS	Beau Logue	Curtin University
Charu Sharma	West Leeming PS	Shane Alexander	Southern River Coll
Diane Milentis	Edgewater PS	Emma Leitner	Southern River Coll
Bernadine Blechynden	Rostrata PS	Cameron MacPherson	Southern River Coll
Annette Martin	Inglewood PS	Fiona Kerrell-Vaughan	Cape Naturalist College
		Brendan Forbes	Department of Education

Team representatives		Others	
David Blair	Li Ju	Michael Garrett	Cinglevue
Mario Zadnik	Elaine Horne	Randa Siksek	Cinglevue
Rahul Kumar Choudhary	David Wood	Samantha Kaye-Johnson	Cinglevue
Tejinder Kaur	David Treagust	Michelle Corby	Cinglevue
Ron Burman	Massimo		

Apologies and other contacts

Nerelle Phillips	Joondalup PS	Rachael Whitehouse	Katanning SHS
Kylie Keown	Baler PS	Anna Burrowa	Kununurra DHS
Melissa Wolfenden	Rapids Landing PS	Sandra Papantoniou	Perth College
Craig Murphy	Spearwood Alternative School	Charlottte Rebello	Thornile SHS
Denise Stone	Spearwood Alternative School	Aneela Narwaz	Kalgoorlie-Boulder Community College
Stephen Spice	Duncraig SHS	Marina Pitts	Willetton SHS