COLLAPSING SCHOOL PHYSICS ENROLMENTS: MICRO-CREDENTIAL COURSES FOR UPSKILLING TEACHERS IN EINSTEINIAN PHYSICS

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SUBTHEME: Empowering educators

This paper presents an analysis of novel micro-credential courses that have been developed as part of a response to the catastrophic decline in high school physics enrolments from 2015 to 2023 in which the gender gap is also seen to be increasing. In this context we present the need for disrupting the existing school curriculum, so as to replace obsolete 19th century content with modern content consistent with our best modern “Einsteinian” understanding of physical reality. Next, we summarise the Einstein-First curriculum and present trial outcomes of a school science curriculum called *Eight Steps to Einstein’s Universe* and *Math’s for Einstein’s Universe,* including results that show outstanding benefits in terms of student attitudes to physics and gender equity. These positive outcomes motivate the need for large scale retraining of teachers. We describe the initial professional development trials and a novel learning sequence in which models and activities are used to introduce concepts to help minimize negative reactions to abstract concepts, thereby avoiding anxiety. This approach, implemented in a four-unit online micro-credential course is described along with evaluation outcomes. Preliminary evidence from this course demonstrates the effectiveness of the teacher upskilling and discuss the benefits of offering upskilling programs in physics without pre-requisites, which offers the possibility for extending physics education far beyond the conventional demographics.

BACKGROUND

Need for a new approach to school physics: Enrolments in school physics programs are declining in the developed world. Figure 1 shows that high school physics enrolments in Western Australia (WA), which generally maps national trends, have been in a steady decline since 2015. Female student numbers have halved while male student numbers have reduced to about 60% of 2015 numbers. This has occurred despite significant population growth in this period. The decline is roughly linear and if extrapolated indicates that the number of female students will be close to zero by 2032, with male student numbers not far behind. The current decline has been foreshadowed for several decades. Many initiatives including the creation of interactive science centres were undertaken worldwide. In WA a specialist science centre called the Gravity Discovery Centre was created to promote Einsteinian physics (Blair et al., 2006).

In 2011, with declining student interest in Science, Technology, Engineering and Mathematics (STEM), and evidence that teenage students perceive school physics as irrelevant and boring, a new approach was investigated. This approach consisted of early introduction of Einsteinian concepts in primary and secondary schools, which has now grown into Einstein-First, a project aiming to replace the classical physics curriculum founded on the works of Euclid and Newton, with a new curriculum founded on the work of Einstein (Kaur et al., 2017a, 2017b).

The value of this new approach is that Einsteinian physics represents a complete paradigm shift. It involves a new mental model of reality where 19th century concepts of light, electricity and heat are replaced with photons, electrons, atoms and phonons. Einsteinian physics replaces the continuous description of reality with a quantum description, along with a probabilistic description of physical reality. This does away with the simple causality of the Newtonian universe. The absolute space and time of Newtonian physics is replaced with the understanding that space and time are stretchy and deformable.

Recently educators and physicists have recognised the importance of modernising of school science curricula as a means of encouraging student engagement in science (Bouchée et al., 2023, Kersting et al., 2018, Khodaeifaal, 2022, Kaur et al., 2024, Postiglione et al., 2021).

In the past educators considered Einsteinian physics to be far beyond the capability of school children (Balta et al., 2022, Foppolli et al., 2019). This was because the new model of reality was generally expressed in abstract mathematical form, and no serious efforts had been made to disentangle the concepts from the mathematics in the context of classroom education. However, it has taken a large effort over more than a decade to develop an appropriate curriculum, and additional effort to create an appropriate upskilling program for teachers. The current crisis in school physics enrolments, foreseen decades ago, makes the transition from traditional science education to Einsteinian science more urgent.

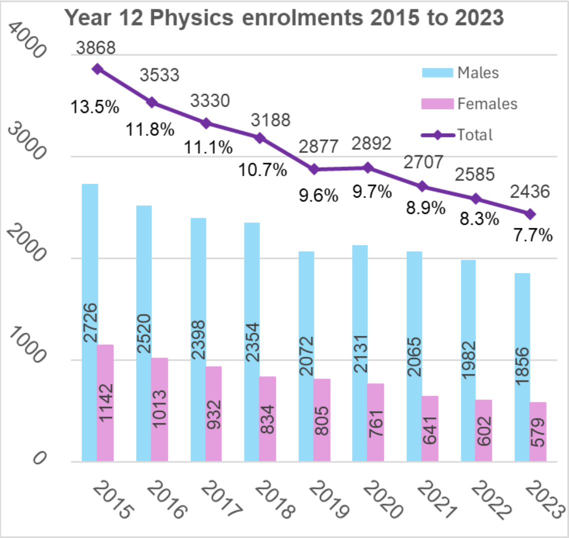

Figure 1. High school physics enrolments in Western Australia have been in a steady decline since 2015. Percentage indicates the proportion of the Year 10 school cohort that chooses physics. Data from the WA Department of Education.

Early introduction to Einsteinian physics concepts offers four advantages:

1. Students experience a seamless progression of learning instead of needing to cope with the paradigm shift required to transition from a Newtonian to Einsteinian world view.
2. Students learn about modern topics such as quantum computers or time dilation that cannot be explained by classical physics.
3. Students are prepared with the conceptual foundation needed for more abstract and mathematical specialist senior school physics.
4. The majority of students who will not progress to senior school physics will be equipped with basic knowledge and language important for understanding their modern technological world.

Primary and middle school are deeply embedded in 19th century concepts as they are the only concepts experienced by most teachers. Radical disruption of the traditional school science curriculum is required. The paradigm shift is difficult for adults, because it requires changes in our deeply held internal models of reality that we learnt as children. This is further exacerbated by the entrenched but quite incorrect view that Einsteinian physics is only for the highly mathematically talented.

The Einstein-First project discovered that students easily appreciated the modern picture of physics (Kaur et al., 2024). The international replication of trial results (Ruggiero, 2021; Vakarou et al., 2024;

Dua et al., 2020) showed strong uptake of Einsteinian concepts and that overall student engagement was boosted amongst disadvantaged students and those with learning difficulties. An important outcome was the boost in positive attitudes to science amongst 14–15-year-olds, including a very strong gender-equalising effect (Kaur et al., 2020). Many papers report results of trials with different age groups (Dua et al., 2020, Chaudhary et al., 2020, Kaur et al., 2020).

CONCEPTS OF THE EINSTEIN-FIRST CURRICULUM.

Following the series of trials that demonstrated the transformational power of early teaching of Einsteinian physics, the Einstein-First team set about creating an eight-year curriculum from year 3 to year 10, the last compulsory year of science education. *Eight Steps to Einstein's Universe*, and *Maths for Einstein's Universe*, consist of a continuous spiral sequence of learning (Figure 2). Our objective was that by age 16, all students, whatever their ability and background, should have a basic understanding of the revelations of modern science that are currently reserved for specialists (Popkova et al.,2023).

To meet our objective we designed group activities, often involving toys and models, songs, and plays. They allowed photons, black holes, space travel and quantum science to be introduced at an early age along with the concepts of modern technology like phones, solar panels and medical imagers. The Einstein-First team developed special expertise creating engaging ways of translating Einsteinian physics into simple, intuitive, and easy-to-follow activities. The team adopted the Model of Educational Reconstruction (MER) (Duit et al., 2012) as its primary methodology to create an evidence-based curriculum, which has been evaluated at each stage of development.

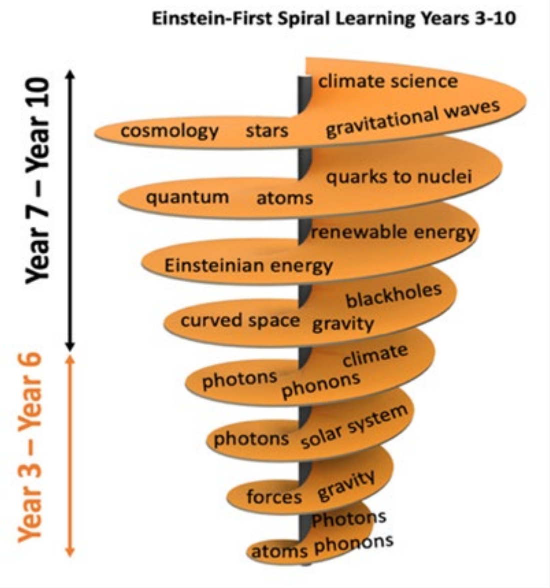

Figure 2. Spiral curriculum for Einsteinian science from Years 3 – 10

Einsteinian language and concepts are introduced through toys, role plays and songs in Years 3-6, and then revisited at more sophisticated levels between Years 7 and 10. For example, phonons and atoms are introduced in Year 3, and revisited in Years 5, 6, and 9 and the concepts of space, time and gravity are introduced in Year 5, and then revisited in Years 7 and 10. All lessons are based on simple easily explained group activities. The program culminates in climate science including understanding how infrared photons are absorbed by CO_2 molecules, and cosmology, the life-story of the Universe - the creation of atoms, planets, stars and galaxies. The lessons combine to form a pedagogically sound and cohesive curriculum supported by data and rigorous analysis.

We began with one primary school and one high school, but public demand, corporate donations and Commonwealth support allowed us to grow, and spread into regional schools. In 2023 Australia's Chief Scientist Cathy Foley launched the program nationally at the Australian Academy of Science, and by 2024 Einstein-First had expanded into three states, with more than 50 schools and 150 trained teachers participating.

Our long-term objective is to bring Einstein-First to all Australian students (9500 schools). If a deep appreciation of the universe around us can be part of every student's worldview before their last compulsory year of science, Australia's future as a STEM-literate nation will be assured. However, to meet this objective we faced a major problem: most teachers share the view of Einsteinian science being much too difficult to understand. This paper describes the methodology used to overcome teachers' lack of confidence and presents preliminary results indicating upskilling through micro-credential courses based on a novel pedagogical approach is effective and allows teachers to teach a modern Einsteinian curriculum from Years 3-10.

APPROACH TO UPSKILLING TEACHERS

Professional development of teachers is widely recognized as a powerful instrument for introducing new ideas into the school curriculum. Researchers recognise that while a strong curriculum is beneficial, it must be paired with ongoing professional development to be effective (Cammarata & Haley, 2018). Even modest professional development initiatives can substantially enhance teacher performance (Heller et al., 2012). While the curriculum creates the overarching framework for what should be taught in schools, teachers translate and deliver the curriculum, thereby playing a fundamental role in determining teaching quality and the success of educational systems (Hanushek & Rivkin, 2006; Hattie, 2008; McKenzie & Santiago, 2005).

Shulman (1986) identified subject-specific and pedagogical content knowledge as key aspects of teachers' professional knowledge. Low self-efficacy in teachers causes anxiety, leads to avoidance of teaching science, and results in resistance to change (Ahmed, 2019; Swars & Dooley, 2010). Upskilling programs for teachers that emphasise content knowledge increase teacher confidence and enthusiasm. (Lee et al., 2004).

If educational frameworks are to evolve to incorporate advanced and novel concepts, such as Einsteinian physics, it would become imperative to provide teachers with comprehensive upskilling training (Stenhouse, 1975). We believe that, given the proposed dramatic shift in the educational paradigm, upskilling teachers should be systematic and progress through key ideas and concepts in the same manner as it is done for school students. Understanding the entire learning progression from the very beginning is a key component in building confidence.
The challenge for upskilling teachers, whether or not they have science backgrounds, arises because a) most have no in-depth prior knowledge of Einsteinian physics, and b) they generally share the popular view that Einsteinian science is too difficult to comprehend. Over a period of four years, we trialled numerous teacher professional development workshops in which we tested different approaches. It was frequently observed that teachers became anxious when faced with abstract descriptions of concepts such as curved space and photons. However, they were much more comfortable when the ideas were introduced with activities based on toys and models, that had been developed for children. We observed that models and toys were equally appreciated by science-trained teachers and those without science backgrounds. This led to us adopting an *activity-first approach* in which the learning sequence consists of three steps. First we present or demonstrate a toy or model that represents a concept. Second we use the model to explain the relevant concept. Third, we criticize the model because significant learning is achieved through discussions of the ways that the learning models are *incorrect* and have incomplete representations. Thus, models support the learning in two ways: one by the usefulness of the analogy that is created, and one by analysing the ways that the analogy is wrong. In all cases the learner carries memory of a tangible object or process that aids in creating mental models to support conceptual understanding.

Given the importance of modernising school science, we began a series of trials of teacher professional development models with view to enabling teachers without backgrounds in Einsteinian physics to teach Einsteinian concepts across the target age range, years 3-10. Kaur et al reports the results of a pilot trial on upskilling teachers through focussed professional development sessions and short and intensive micro-credential courses (Kaur et al., 2024). This study provided valuable insights into how teachers can be equipped to introduce Einsteinian physics into their classrooms. Through both the workshops and short micro-credential courses, teachers can gain the necessary knowledge and confidence to teach Einsteinian physics effectively, even with limited prior experience in this area. The research findings from the pilot trials served as a foundation for creating systematic micro-credential courses for primary and secondary teachers, encompassing the entire learning progression, which is described below.

EINSTEINIAN SCIENCE FOR SCHOOL TEACHERS: MICRO-CREDENTIAL COURSE OUTLINE. The Einsteinian Science micro-credential course is a four-unit online program designed to enhance primary and secondary teachers understanding of modern physics concepts and improve their teaching methodologies. Supported by the Australian Government's Micro -Credentials Pilot in Higher Education and developed in collaboration with the Science Teacher's Association of Western Australia (STAWA), this course targets teachers and educators with varying levels of prior science education, including those who have not previously studied maths or science at an undergraduate level. The course covers the full Einstein-First Year 3-10 curriculum and includes extensions for the upper secondary level. The main components of the course are presented in Table 1.

Table 1. Micro-credential course structure

Online lessons	Five to six 10-minute videos, each explaining the week's main concepts, as part of an overall structured learning sequence.
Activity videos	3-minute videos that concisely demonstrate how to deliver activities in the classroom and highlight related concepts.
Fortnightly workshops	Live activity demonstrations with teacher participation and discussion.
Tutorials	1-hour meetings to support learning and answer questions.
Home readings	Self-guided reading of prepared materials related to the online lessons.
Assessments	Weekly quizzes featuring multiple-choice and short-answer questions, and term presentations/essays on physics and educational concepts.

The course includes four units (Table 2) which closely follow the Einstein-First modules. Teachers learn from many of the same activities and worksheets as the students. Where feasible teachers are encouraged to perform activities at home, alongside the video demonstrations and participation in live interactive workshops. The course includes a total of four 6-week units (Table 2), requiring a weekly commitment of 3-5 hours, focusing on different aspects of the Einstein-First curriculum.

Table 2. Units' Description

Unit I: Atoms, Light, Space and Climate	Years 3-6 of the EF curriculum covering powers of 2 and 10; maths of arrows (vectors); atoms & molecules (including protons, neutrons, and electrons); electricity and magnetism; heat, sound, phonons, and states of matter; non-Euclidean geometry, spacetime, and gravity; photons, interference, and spectra; and the greenhouse effect and climate drivers.
Unit II: Gravity, Energy, and Quantum Mechanics	Years 7-9 of the EF curriculum covering gravity; special relativity; the equivalence principle and the development of general relativity; mass and energy ($E = mc^2$, $E = hf$ and binding energy); renewable energy and energy systems; electromagnetism; phasors and interference; quantum waves; quantum spin, fermions, and bosons; and the uncertainty principle.
Unit III: Climate to Cosmology	Year 10 of the EF curriculum covering the history of climate science; Planck's blackbody spectrum; tipping points; the evolution of Earth's climate and planetary atmospheres; the Big Bang and evolution of the Universe; the cosmic microwave background; nucleosynthesis; formation of planets; telescopes and redshift; the Drake equation and Fermi estimation; black holes, dark matter, and dark energy
Unit IV: Modern Science in the Real World	This unit applies prior learning to advanced topics such as quantum technologies and quantum computing; modern astronomy (including telescopes, adaptive optics, arrays, and gravitational wave observatories); black holes and cosmology; and nuclear fission and fusion technology.

The course aims to provide educators with the tools to offer students the best possible preparation for life in the modern world of science and technology by aligning the school curriculum with contemporary science and technology. It is designed to give educators the knowledge, the language and the resources to discuss advanced science topics such as black holes, quantum computers, climate change, or interstellar communication. Familiarity with the language and concepts of modern science also enables participants to creatively and critically use the internet for exploring new topics.

METHODOLOGY

As mentioned above, the team adopted the Model of Educational Reconstruction (MER) (Duit et al., 2012) which had already been used to develop the spiral curriculum, as its primary methodology to create an evidence-based curriculum, which has been evaluated at each stage of development. The MER is a widely recognized framework in science education for optimization of new educational material. It includes rounds of design, trials, measurements of results and feedback which are used in further rounds of optimization. It leads to the creation of optimum pedagogical approaches based on evidence which in the present case includes post-tests, interviews, and feedback questionnaires.

PARTICIPANTS

The EF team advertised the courses through their existing networks in the public and private school sectors across Australia. The courses were open to teachers from diverse backgrounds, with no prerequisites required. There are 26 participants enrolled in the course, and they were self-selected. Information about their science backgrounds is given below in Table 3.

COURSE IMPLEMENTATION

As mentioned above, the micro-credential course is delivered fully online. In this course, every week participants have 4-5 hours of home reading, 3-4 hours of online lectures, one hour of live tutorials, and one hour of live demonstrations of activities.

ASSESSMENT SURVEYS

To assess changes in teachers' understanding of Einsteinian physics concepts and their self-efficacy, the team created a short knowledge-based questionnaire and a feedback survey. These surveys were adapted from previous trials, with some modifications made by the EF team (Kaur et al., 2024). The survey consists of both Likert scale items and open-ended questions and was finalized after several iterations conducted with experts in education and physics.

The knowledge questionnaire primarily focused on how participating teachers' understanding shifted from Newtonian to Einsteinian concepts. The feedback survey aimed to gather participants' views on the effectiveness of the online course format, their confidence about delivering the EF program to students, and their opinions on teaching Einsteinian concepts using hands-on approaches.

In addition to the knowledge and attitudes survey, the team also developed short quizzes that teachers had to complete after the completion of every topic. These quizzes helped the team address any misconceptions and track learning progress. In this paper, we report only the results from the knowledge and attitude surveys and include some quotes from the quizzes.

Following the conclusion of the course, participants will also be invited to be interviewed to provide in-depth feedback and follow-up surveys will be administered 12 months afterwards to assess the impact of the course on their teaching practice and student outcomes.

At this stage of the pilot trials, we emphasize qualitative results over statistical analysis. It is necessary to modify the program according to the model of educational reconstruction. A comprehensive statistical analysis will be conducted after the program is completed by a statistically significant number of teachers.

DATA COLLECTION AND ANALYSIS

The data was collected online and analysed by the team. The responses to the Likert scale items were counted to determine the number of participants who agreed or disagreed with each item. The open-ended questions were evaluated using the marking key set by experts at the time of creating the questionnaire.

RESULTS

In this section, we present a summary of the most significant outcomes from the evaluation of twenty-six participants with diverse science education backgrounds, representing all who completed Unit I. Their educational backgrounds are shown in Table 3.

Table 3. Class demographics by the highest level of physics study that participants have completed

Level	**N**	**Level**	**N**
Year 10	5	First-year university	9
Year 11	3	Second-year university	2
Year 12	4	Postgraduate	1
Other	1	N/A	1

Then we present assessments of three areas: A) the usefulness of the course and their confidence to teach Einsteinian physics; B) the degrees of interest and difficulty of topics in the course; and C) how participants coped with the paradigm shift for selected topics (Tables 4-6).

A) COURSE USEFULNESS AND TEACHER CONFIDENCE TO TEACH EINSTEINIAN PHYSICS. Table 4 presents the results of a Likert scale questionnaire designed to measure participants confidence and understanding of Einsteinian physics concepts. The important result is that almost all participants (96%) identify the importance of integrating Einsteinian physics concepts into the school curriculum. Additionally, 92% of participants appreciate the significance and relevance of Einsteinian science concepts, in everyday life.

Table 4. Teacher's feedback on the course's usefulness and their confidence in teaching Einsteinian physics (N=26)

Questions	*SA%*	*A%*	*D%*	*SD%*	*NA%*
I found this unit useful and informative	73	26			
I am clear about the resources needed to teach the unit content	50	42	8		
I am clear about the relevance of Einsteinian science concepts covered in this unit in our daily lives.	46	46	8		
I understand why Einsteinian science concepts covered in this unit are important to introduce into the school science curriculum.	61	35	4		
I have hesitations about incorporating Einsteinian science concepts covered in this unit into my educational practice.	4	27	31	38	
I would feel confident running individual Einstein-First activities covered in this unit for my students.	35	61	4		
I would feel confident running one of the full Einstein-First modules covered in this unit for my students.	42	46	8	4	
Descriptions of Einstein-First activities assisted with my understanding of the concepts.	46	54			
Learning about concepts related to year levels other than those which I teach was useful to my own educational practice.	34	54	4	8	
Einsteinian science concepts were explored in sufficient depth in Unit I for me to teach them at a primary level	31	46	8	4	11

Note: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree, NA = Not Applicable

Most participants (88%) express confidence in conducting individual Einsteinian physics activities, as well as complete modules in their classroom. This response diverges somewhat from the more open-ended question about hesitancy in the context of general educational practice. While two-thirds of participants disagreed or strongly disagreed that they were hesitant, these answers suggest that in the context of well laid-out programs they were confident, but for more general application their breadth of knowledge was insufficient. It is pointed out that the participants undertook this evaluation after Unit I and before they had completed the entire course, which would have greatly deepened their knowledge. All participants (100%) believe that the descriptions of activities enhanced their understanding of the concepts. Furthermore 92% of participants felt they have a clear understanding of the necessary resources, reflecting good understanding of delivering activities into classrooms. Most participants (88%) found learning about concepts for different grade levels was useful, suggesting the spiral learning sequence promotes a deeper comprehension of particular topics. Furthermore, 77% of participants feel that the concepts were explored in sufficient depth to teach at a primary level indicating overall satisfaction with the content's depth, with 11% abstaining from the question as they do not teach at a primary level. Another indication of the course's usefulness is that 24 out of 26 participants continued learning after completing Unit 1.

The main conclusion from the results is that the majority of participants in this cohort feel confident in transferring Einsteinian physics concepts to the classroom, whether through individual activities or the entire module. Notably, the confidence does not depend on the participants' level of education.

Only one or two participants require additional educational support in their learning. Additionally, learning through activities has been recognized as a useful way to understand physics concepts. These results encourage us to continue applying this approach and course structure. The fact that one-third of the participants remain hesitant to incorporate Einsteinian science concepts into their educational practices, despite their satisfaction with understanding the concepts and acknowledging their usefulness, warrants further investigation. Additional questions will be developed to clarify this issue.

B) THE DEGREES OF INTEREST AND DIFFICULTY OF TOPICS IN THE COURSE. In Table 5, we present the evaluation of the most challenging and most interesting topics for teachers. The number of interesting topics identified by teachers indicates their enthusiastic involvement in the delivered content. The most interesting topic was photons, which is strongly connected to modern discoveries in quantum mechanics. Teachers also appreciated the use of spacetime simulator activities to understand the concept of gravity. The most frequent responses were ‘curved spacetime’ and ‘photons.’ The majority of teachers mentioned more than one concept as the most interesting topic.

Difficulty is not necessarily a negative attribute especially when paired with interest. However, these results identify areas for the future improvement of the program according to the MER. The rather even distribution of difficult topics likely suggests individual skill variations, which can be addressed through targeted support. Some topics, like curved spacetime, are considered both interesting and challenging simultaneously. A similar pattern has been observed among school students. Students and participants alike respond positively to difficulty, indicating that we should not water-down the difficult topics but perhaps allow more time for them to be explored.

Table 5. Teacher's feedback on the interest and challenge of course topics

Most interesting concepts	***N***	***Most difficult concepts***	***N***
Photons	19	Photons	6
Curved spacetime	10	Curved spacetime	6
Maths for Einstein’s universe	1	Calculations, Maths	5
Climate science	4	Quantum fundamentals	2
Phonons	6		
Atoms & molecules	6		

C) HOW PARTICIPANTS COPED WITH THE PARADIGM SHIFT FOR SELECTED TOPICS.
To assess teachers' conceptual understanding we specifically asked two questions: one about light and the other about gravity. The results are presented in Table 6, which shows that every participant correctly explained light as a stream of photons and gravity as the curvature of spacetime. Additionally, we asked two more questions to evaluate any paradigm shifts in their knowledge. Table 6 indicates that 22 out of 26 participants reported that the course had changed their understanding of light. The remaining four participants were already familiar with the concept of photons, so they had prior knowledge. Similarly, regarding gravity, 24 participants noted that their understanding of gravity had changed after the course. One participant mentioned they were still learning and trying to understand the concept, while the remaining participant did not provide a specific reason for choosing

No. These results suggest that the micro-credential course effectively facilitates the shift from the classical paradigm to the modern physics paradigm.

Table 6. The teachers' paradigm shift for "light" and "gravity" concepts

Questions	*Correct responses*	
What is your understanding of the term "light"?	26 (100%)	
Has completing this unit changed your understanding of light?	Yes: 22	No: 4
What is your understanding of the term "gravity"?	26 (100%)	
Has completing this unit changed your understanding of gravity?	Yes: 24	No: 2

In addition to the results mentioned above, we are presenting a few quotes from the participating teachers in Table 7. They indicate that students have a very positive attitude towards learning various modern physics concepts and intend to incorporate these concepts into their teaching practices

Table 7: Examples of Quotes from Participating Teachers

Participant 1	*"I found photons and phonons very interesting and was surprised at how simple they were to teach at the primary level. I also found the content on climate change science to be very informative and helped tie in the content in the previous weeks together"*
Participant 2	*"Learning a broader background of photons and quantum fundamentals was interesting and will help me with my teaching. Providing the many activities was helpful and I will incorporate some of them into my teaching."*
Participant 3	*"I enjoyed learning about the concepts that were parallel to what I already teach to my seniors and then learning how to fill the gaps in my current practice e.g. quantum physics concepts. I enjoyed the practical and modelling aspects using the spacetime simulator to aid student comprehension."*
Participant 4	*"I found all the concepts equally interesting. It was particularly helpful to look at the science around climate change and see how this can be incorporated into the teaching of Science in primary school"*

Additionally, there was a lot of positive feedback regarding teacher enjoyment and satisfaction. Comments included: "It was excellent. I am extremely happy to be part of the cohort," "I really liked the teaching units aligned with the curriculum and the careful design of activities and demonstrations in each unit," and "In general, this unit has made me rethink what I thought I knew about physics." This feedback encourages us to further develop micro-credential courses.

Some limitations of the results at this stage may be related to the method of participant selection. In this group, we have motivated teachers who took the initiative to learn modern physics through micro-credential courses, without any school requirements.

CONCLUSIONS

Two parallel educational initiatives have been developed in response to the alarming decline in physics students' enrolments. Firstly, we summarized a newly developed Einsteinian science curriculum for years 3-10, that has been created to enable school physics to be taught using activity-based learning in the context of modern discoveries and modern technology. Secondly, to upskill teachers and give them confidence to teach Einsteinian physics at school, an online micro-credential course has been created in which teachers with and without science backgrounds are successfully trained using activities to create concrete representations of key concepts. Prior program-evaluation has provided strong evidence for the efficacy of the Einsteinian curriculum from the student-learning point of view, while the results presented here demonstrate the efficacy of the teacher upskilling. We believe that widespread implementation of these programs will help to reverse the drastic decline in physics enrolments as well as helping to reducing the gender gap in physics. In future we intend to undertake longitudinal studies to determine whether the modern physics programs we have described lead to the desired flow-on benefits in student subject and career choices.

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