

SCIENCE CURRICULUM PROJECT

PROGRESS OF STUDENTS THROUGH THE
SCIENCE CURRICULUM: A FOCUS ON
MATTER (CHEMISTRY)

STAGE I PRE-GRADE 7 REPORT

MARLENE FERIDO

PAM ROBERTSON

ESTHER CARE

MASA PAVLOVIC

SUSAN HARDING

ACTRC

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ACTRC is a partnership between the University of Melbourne and the University of the Philippines, supported by the Australian Government

Assessment Curriculum and Technology Research Centre
UP Campus, Diliman 1101, Quezon City
P: 632-8064680
E: info@actrc.org

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EXECUTIVE SUMMARY

This research is designed to examine the implementation of the spiral curriculum structure introduced in the Philippines as part of the K to 12 curriculum reform. The curriculum emphasizes the understanding and application of scientific knowledge, learning scientific inquiry skills, and developing and demonstrating scientific attitudes and beliefs. The spiral curriculum was initiated with Grade 7 implementation in School Year (SY) 2011/12. By the end of SY 2015/16, this cohort of students will be the first to have completed the full 7 – 10 new curriculum.

Due to the recency of the reform, how its characteristics and design have influenced outcomes is yet unknown. How is the curriculum implemented by teachers? Does the teacher's specialisation influence student outcomes? How do other factors such as teacher training, experience, student access to materials, and school size influence student outcomes? How do the students skills progress as they complete the curriculum? Is spiraling handled differently across year levels?

This research is designed to investigate the progress of students' conceptual knowledge and skills for each unit of Chemistry ("Matter") over the four years of the junior secondary curriculum. Identification of progress is achieved by assessing students in Grades 7 - 10. Data representing factors presumed to influence student learning outcomes include teacher information, lesson plans, and classroom observations of selected classes.

This report covers the data obtained in order to address the research question:

Do students enter junior high school with the level of conceptual knowledge and skills they need to engage with the Grade 7 science (chemistry) curriculum?

The report includes analysis of data obtained from a pre-Grade 7 test on chemistry related skills. The pre –Grade 7 test is developed to assess if students are appropriately prepared to access the new curriculum. Students were tested at the start of the school year, June 2015, before beginning the chemistry unit "Matter" (or any other secondary school subject). In summary, the student results indicate that the sample assessed were distributed normally across the test. Although this demonstrates that the test itself is well-targeted for the population, these results imply that a proportion of students entering Grade 7 are not well-prepared to engage with the conceptual knowledge and skills required by the Grade 7 chemistry curriculum. Details concerning those knowledge and skills best and least well demonstrated are described in the report.

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SECTION I: INTRODUCTION

In 2012, the Philippine Department of Education (DepEd) initiated a basic education reform. This reform is known as the K to 12 program. This program covers Kindergarten and 12 years of basic education; six years of primary education, four years of Junior High School, and two years of Senior High School. The rationale for this reform is to provide sufficient time for mastery of concepts and skills, develop lifelong learners, and prepare graduates for tertiary education, middle-level skills development, employment, and entrepreneurship.

In the K to 12 program, a new curriculum for science has been implemented in schools across the country. Through this curriculum, the aim is to develop scientific literacy among students such that they are able to make judgments and decisions on the applications of scientific knowledge that may have significant impact in everyday life (DepEd, 2013). The new curriculum is designed according to the three domains of learning science: (1) understanding and applying scientific knowledge, (2) performing scientific processes and skills, and (3) developing and demonstrating scientific attitudes and values.

The new curriculum includes statements outlining the progression of science inquiry skills and expectations of the rate at which students will develop these skills, addressing some of the recommendations resulting from a comparison of the Philippines curriculum with those of three countries (Care & Griffin, 2011). Concepts and skills are presented with increasing levels of complexity from one grade level to another in spiral progression to develop a deeper understanding of core concepts.

DepEd implemented the new curriculum for Grade 7 (1st year Junior High School) in public schools during SY 2012-2013, and it is being progressively introduced in other grade levels. In SY 2014-2015, it was implemented with Grades 3, 7, 8, and 9 respectively. In the SY 2015-2016, the new curriculum for Grades 4 and 10 is implemented in all public elementary and secondary schools.

This project was designed to investigate how students' knowledge of the science content and their inquiry skills develop through the spiral curriculum.

Determining what students know and can do at various stages can be used to inform subsequent teaching and assist with future reviews of the science curriculum domains and learner modules.

1. investigate the progress of students' knowledge and skills as they complete the spiral science curriculum, with emphasis on whether students have developed the pre-requisite knowledge for the next year of study
2. *determine the level of conceptual knowledge and skills students have developed before they enter junior high school*
3. determine the level of conceptual knowledge and skills achieved after four years of the spiraling curriculum
4. assess the effect of factors such as previous teacher specialisation, teacher training, experience, student access to materials, and school size, on student achievement, and curriculum implementation

5. investigate extent to which teachers are implementing science inquiry teaching practices in the Grade 7 Chemistry classroom, where science inquiry is specifically outlined as a content component.
6. determine the relationship between teachers' implementation of science inquiry practices and students achievement of science inquiry skills.

METHOD

This study has as its focus the chemistry component of the spiral curriculum - Matter. In junior high school, Grade 7 students complete Matter as their first unit of science study (Table 1). This fact provides the opportunity for base-line measurement of student understanding and skills. Only in the Grade 7 chemistry curriculum is science inquiry explicitly listed as a conceptual topic to be covered. Note that tracking of progress is not contingent on a longitudinal study design. A design mix of longitudinal and cross-sectional is implemented. The primary reason for this choice of design is to produce results and information useful to DepEd in as timely a manner as possible.

Table 1. Curriculum focus by quarter across grades

	G6	G7	G8	G9	G10
1st Quarter	Matter	Matter	Force, Motion & Energy	Living Things and Their Environment	Earth & Space
2nd Quarter	Living Things and Their Environment	Living Things and Their Environment	Earth & Space	Matter	Force, Motion & Energy
3rd Quarter	Force, Motion & Energy	Force, Motion & Energy	Matter	Earth & Space	Living Things and Their Environment
4th Quarter	Earth & Space	Earth & Space	Living Things and Their Environment	Force, Motion & Energy	Matter

PARTICIPANTS

DepEd regular high schools and science-oriented high schools from the National Capital Region (NCR) are targeted in this study, as well as high schools in Regions VI and VII. The science-oriented high schools are a particular case of interest, in view of the presumption that these schools might have teachers with more expertise in the teaching of science and who may therefore implement the curriculum somewhat differently to teachers within the mainstream. NCR is selected due to its relatively large population, and therefore for providing for a relatively large number of students with elementary and secondary education. Regions VI and VII (Western and Central Visayas) are selected due to their inclusion within the BEST initiative.

Development phase

As part of the development of the assessment tools, approximately 200 students enrolled in 2-4 schools in the Metro Manila region take each year level test (for Grades 7, 8, 9 and 10) to provide item level data to contribute to the test development. Each grade level test development activity comprises:

- a. Curriculum analysis and identification of major themes/skills for analysis
- b. Drafting of items
- c. Item review and selection of items for pilot test form
- d. Administration of items to pilot participants
- e. Analysis of pilot quantitative data
- f. Finalisation of grade level test.

Research phase cycles

For the research each year, 16 schools are recruited. Four of these are each in Region VI (Western Visayas), Region VII (Central Visayas), NCR, and NCR Science-oriented High Schools. Three sections within each school are selected for participation. The primary activity in each school comprises student assessment. In some schools, classroom observations are to be undertaken across sections. This provides the opportunity to identify degree of alignment between planned and implemented curriculum, and in addition examine the possibility that delivery of the curriculum may vary across sections.

RESEARCH DESIGN

For the main study, students are tested directly before completion of each unit of Chemistry. The rationale for this approach draws attention to depth of student learning, as opposed to knowledge acquisition or surface learning. The approach provides an indication of the skill level of students prior to each relevant quarter, and the level of skill retained from the previous relevant quarter. The skill level is indicative of the knowledge, skills, and understandings retained long-term from previous units of the subject.

The dependent variable throughout the phases of the study is student outcomes, as measured through tests of chemistry knowledge and skills developed in alignment with the curriculum. Independent variables to explore include, variably across phases, chemistry content delivered, teacher, teacher training, science specialisation, access to materials, class size, school type and school, province. Confounding variables include homogeneous/heterogeneous student grouping, socio-economic status (SES), language background, metro/regional/rural location.

Student assessment schedule

The phases of the study are scheduled in order to assess each grade level as they begin the Chemistry quarter within the shortest amount of time possible, in order to expedite feedback of results to DepEd.

Pre7 Jun 2015 before Unit 1, Grade 7 Chemistry (SY2015/2016)

Post7 Grade 7 sub-study end of QTR 1 (SY 2015/16)

Pre8 Nov 2015 before Unit 3, Grade 8 Chemistry (2015/2016)

Pre9 Aug 2016 before Unit 2, Grade 9 Chemistry (2016/2017 school year)

Pre10 Jan 2016 before Unit 4, Grade 10 Chemistry (2015/2016 school year)

Post10 Mar 2016 after Unit 4, Grade 10 Chemistry (2015/2016 school year)

For a sub-study, Grade 7 students in SY 2015/16 classrooms will be observed in order for information specific to science inquiry to be collected. In addition, some classes of these students will complete a post-test following the Grade 7 Matter quarter in order to determine progress in student inquiry skills in particular, from beginning to end of quarter. This sub-study comprises the doctoral thesis of Mr Dennis Danipog, an Australian Endeavour Awardee, enrolled at the University of the Melbourne, under the supervision of Dr Esther Care, with formal co-supervision by Dr Marlene Ferido of NISMED.

INSTRUMENTS

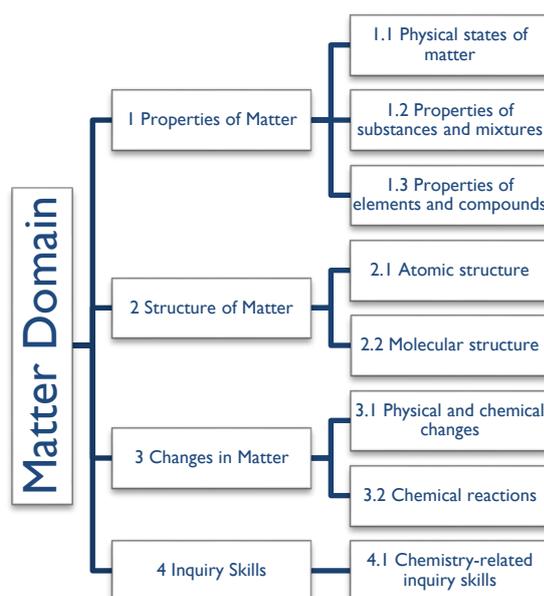
For Students

Tests are developed to assess student learning. Five linked tests are developed in order to locate students across the grade levels of interest in the study on the same scale. The tests of approximately 50 items are linked by sets of common items. The use of common items enables the comparison of student acquisition of skills and knowledge across different grade levels. The process of test development includes initial curriculum mapping and development of test blueprint, item development, item review and selection for pilot, analysis of pilot data, followed by selection of items for the final test form.

The set of chemistry tests for the curriculum study are designed to cover the concept domain (Matter), strands (Properties, Structure and Content, and Inquiry Skills) and sub-strands (Figure 1). Each strand is not covered in the same proportion across the five tests. This is a consequence of the curriculum design which the tests reflect. The set of tests for the full study include:

1. Pre-Grade 7 (Base-Line or Entry Level)
2. Pre-Grade 8
3. Pre-Grade 9
4. Pre-Grade 10
5. Post-Grade 10 (Final)

Figure I. Matter test domain structure



PROCEDURES

The main procedures are associated with:

- liaising with DepEd Central and in NCR, Regions VI and VII for the purposes of recruitment
- recruitment within the NCR for the purposes of piloting tests
- fieldwork associated with research data collection from students and schools
- analysis and reporting.

DATA ANALYSIS

Student data are collected via pencil and paper tests, with student responses provided on scannable forms. Completed forms are then scanned, and raw data cleaned prior to analysis. All tests are developed and scored based on Item Response Theory. Test results are to be used primarily as an indication of student learning in research reports to be provided to DepEd. In addition, individual class results in aggregated form are provided to participating schools in order to provide teachers with relevant information about student learning levels, and hence their most appropriate level for teaching and learning interventions. At no point in the study are any individual student scores or grades reported. For school use, student results across descriptive skill levels are provided.

SECTION 2: INSTRUMENT DEVELOPMENT PRE-GRADE 7

The curriculum audit was accomplished in a workshop in March 2015. Participants were six UP NISMED science education specialists, two UP Integrated School science faculty, one science education faculty of the UP College of Education, one ACTRC staff member, and ACTRC's Program Leader for Curriculum. The curriculum audit involved curriculum analysis and identification of concepts and skills for the Grade 7-10 science curriculum. To make the curriculum audit more efficient, two or three experts were grouped to work on each of the grade levels (Grades 7 to 10). The blueprint to structure the development of test items was created using the audit information. This included what concepts and skills students need to have in order to access a specific grade level chemistry curriculum.

The blueprint took into account the following questions:

- What strands run through the different grades?
- What is the most communicative terminology to use for these strands?
- What strands appear only at one/some grades?
- What is the relative importance of the categories/strands at each grade level?

To articulate the skills integral to each grade level of the curriculum, specific behaviours that a student could demonstrate were identified. Behaviours that could be demonstrated in a pen and paper test were written for each statement. Where the same behaviours appear at multiple grade levels, these were noted at each relevant level. The behaviours were also classified as 'essential' or 'advantageous.'

The blueprint section for the Pre-Grade 7 test is shown in Appendix I. The blueprint includes the pre-requisite concepts and skills considered necessary for students to engage in the Grade 7 Matter curriculum. These pre-requisites were searched for in the Grade 3-6 curricula. It should be noted that some of the pre-requisite concepts and skills are not explicitly stated within these curricula. Despite this, the pre-requisites were included in the test blueprint due to the Grade 7 curriculum demand.

After the two-day workshop on curriculum audit, another two-day workshop on item writing and review took place, focusing on guidelines for writing test items, multiple choice terminology, and multiple choice guidelines. Sample test items were provided. The experts drafted and panelled multiple choice test items. Following Day 1 of this workshop, the blueprint was revised: (1) the domain (conceptual knowledge and skills), strands, and sub-strands were reviewed; (2) the distinction between essential and the advantageous behaviours was elucidated, insofar as essential behaviours are those that a student needs to have achieved to engage with the demand of the (next) year level, while advantageous behaviours are not essential but enhance their progress; (3) capabilities (what we want students to be capable of) were reviewed [added,

deleted, modified or moved]; (4) indicative behaviours (those behaviors that allow test developers to infer if students have the capability) were assigned to capabilities; (5) indicative behaviors were reviewed; and (6) indicative behaviours were linked to grade levels. Finally, numbered statements and behaviours were incorporated in the test blueprint.

Multiple-choice test format was selected as the most efficient method of assessing at large scale. The advantages of the format include student familiarity, ease of administration, and cost-effectiveness of scoring.

The item writing responsibilities were shared between team members located in Metro Manila and those in Melbourne. All items were written to the test blueprint. Once each item was written and the skill identified, it underwent a paneling process to enhance item quality. Each item was paneled twice, by team members in each geographical location. This process drew on the expertise of all team members and ensured items adhered to guidelines for best practice in objective item writing and contained language and concepts that were Philippines appropriate.

Examples of the types of items written are shown below. Due to the need for test security, these are not actual items from the test.

Example 1:	Which of the following is a gas?
A.	steam
B.	soup
C.	chalk
D.	flowers

Example 2:	Sam suspects that there are iron filings in a powder sample given to him.
	To confirm this, he suspended the powder sample in water and stirred it.
	Which step will help him confirm the presence of iron filings?
A.	Allow iron filings to float
B.	Allow iron filings to settle at the bottom of the beaker
C.	Use magnet to attract iron filings
D.	Use magnet to attract other particulates

Example 1: By using options that are not commonly used when teaching solids, liquids and gases, this item requires students to apply their knowledge of states of matter. For students who have developed an understanding of each of the states of matter, they can apply this understanding to answer the item. For student who have rote learned examples of common solids, liquids and gases, the unexpected options prevent them from answering the question. Being able to understand the differences between solids, liquids and gases will assist

students when they come to learn about solutions in Grade 7. In addition, understanding that sets of materials have common properties from which generalisations can be made will help them when they are introduced to learn to distinguish between substances and mixtures, elements and compounds, and acids and bases in Grade 7.

Example 2: This item uses the familiar context of separation of mixtures (taught in Grade 6) to get students to apply their knowledge about metals. The students need to recognise that iron is a metal and that magnets attract many metals, connect these ideas and apply them to the given context. This is a more complex skill than simply asking if magnets attract iron. Being able to connect ideas about metals and their properties will assist the students when learning the more detailed properties of metals and non-metals, such as malleability, ductility and conductivity in Grade 7.

PILOT SAMPLE

For the piloting of the pre-Grade 7 test, N = 197 students from a special summer school in the Metro Manila region sat the test in May 2015. This convenience sample of students were thought to be of approximately similar ability to those beginning junior high school, and were selected in order to expedite the research cycle. The purpose of the pilot was to evaluate the performance of each item and to obtain item characteristics in order to develop a psychometrically sound test.

Data from the pilot sample were analysed using the one parameter simple logistic model (Rasch, 1960). The items were found to fit the model, showing that they measure the same construct and that the spread of the items were appropriate for the student sample. Test items were examined for item fit, discrimination, and difficulty.

From the results of the analysis, 48 items were identified for use in the final test. These items were selected on the basis of sound psychometric qualities and coverage as specified by the test blueprint. The distribution of the items against the test blueprint and a sample of key concepts and skills tested are shown in Table 2.

Table 2. Pre-Grade 7 Test Contents

Strand	Number of items	Key concepts/skills
1.1 Physical states of matter	8	Properties and examples of solids, liquids and gases
1.2 Properties of substances and mixtures	10	Separation techniques; properties and examples of mixtures; properties and examples of acids and bases
1.3 Properties of elements and compounds	3	Properties and examples of metals and non-metals
2.1 Atomic structure	2	Elements and atoms; electrons and electric current
2.2 Molecular structure	1	Link between physical properties and molecular structure
3.1 Physical and chemical changes	5	Phase changes; rusting
3.2 Chemical reactions	0	NA
4.1 Chemistry-related inquiry skills	19	Measuring skills; reading scales; observation, evidence and inference; scientific method, including control of variables; interpreting data tables; graphing
Total	48	

The test performed well. The spread of items matched the range of student abilities, providing a reliable tool for the measurement of student abilities. The person-separation reliability of the test was 0.863. (Note, this index is comparable to alpha reliability and is well within the acceptable range.)

SECTION 3: RESEARCH PRE-GRADE 7

CHARACTERISTICS OF THE PRE-7 SAMPLE

Four schools in each of Regions VI and VII, and eight schools in NCR were recruited, providing a sample size of 16 schools in all (the NCR sample was distributed across regular high schools and science-oriented high schools). Twelve full classes from each of the regions were targeted. Schools were requested to provide classes distributed across sections, in order to ensure a heterogeneous sample. For the regular schools in each of the three regions, 2-3 teachers were selected to have their students assessed, providing a total of approximately 10 teachers for each region. The four science-oriented high schools provided one teacher per school. In total, N = 1997 Grade 7 students were assessed. They studied across 47 different classes, 33 different teachers, and 16 schools in 3 regions (Table 3).

Table 3. Test Set-up for Pre-Grade 7 Research Phase

Region	School Type	Schools	No. of Teachers	No. of Classes
Region VI	Regular	A	2	3
		B	2	3
		C	2	3
		D	3	3
Region VII	Regular	A	2	3
		B	2	3
		C	3	3
		D	3	3
NCR	Regular	A	2	3
		B	2	3
		C	3	3
		D	3	3
	Special science	E	1	3
		F	1	23
		G	1	3
		H	1	3

The sample of students from these classes consisted of more females than males in both regular and science-oriented high schools. The specific numbers are provided in Table 4. Within the science-oriented schools, the special science classes only participated in the study.

Table 4. Distribution of students by region, school type and gender

Region	School Type	Female Students	Male Students	Unspecified	Total
Region VI	Regular	304	253	9	566
Region VII	Regular	289	194	2	485
NCR	Regular	301	241	4	546
	Special science	249	149	2	400
Total		1143	837	17	1997

The test data collected from the student sample was calibrated using the one parameter simple logistic model (Rasch, 1960) and student ability estimates were produced.

Analysis showed there was no statistically significant difference between the performance of male and female students within regular schools. There was, however, a statistically significant difference $t(396) = 2.82, p = 0.005$ between the genders within science-oriented high schools, where male students (mean = 60.8, SD = 6.95) outperformed their female classmates (mean = 58.8, SD = 7.26).

The benefit of Rasch modelling is that the students and items can be placed on the same scale. This enables the comparison of students and the concepts and skills assessed by the test. The common logit scale for the pre-Grade 7 test is shown in Figure 2. The representation is known as a variable map and the distribution of students is shown on the left hand side with students represented by 'X'. The items are shown on the right hand side and each item is shown as a number according to the test order. The logit scale in this map extends from -2.5 to 3 logits. The most difficult item on the test is shown to be Item 11, and the easiest is Item 6 (Figure 2).

The relative positions of items and students are dictated by the data fit to the Rasch model. When an item is positioned next to a student, the student has a 50/50 chance of answering that item correctly. When the item numbers are linked with the concept or skill assessed by the item, the horizontal alignment identifies which concepts or skills the aligned students (as represented by 'X's) are ready to learn. For usability, levels containing similar skills are identified, and a level description written to encapsulate the main ideas that students in each level are ready to learn.

The pre-Grade 7 test conceptually and empirically separate into six levels (A through F). These levels are described in Figure 2.

Levels A to D contain the pre-requisite concepts and skills for Grade 7 Matter. These include concepts such as identifying examples and properties of solids, liquids and gases, and recognizing changes in state such as melting and freezing as

well as skills such as drawing conclusions from results and recognizing scientific aims. Since students in Levels A to D are “ready to learn” these concepts (such as that a gas cannot be held in one’s hand and that solids are not always flat), they have not yet mastered the pre-requisites for Grade 7 Chemistry. Given that these students are distributed across the Levels, obviously some have mastered more of the assessed skills than others. The concepts and skills in Levels E and F are beyond those identified by the expert group as being pre-requisite knowledge. For example, linking different states of matter to the particulate nature of the substance is advantageous, but not pre-requisite for Grade 7 Matter. Similarly, the skill of controlling variables is taught as part of scientific method within Grade 7, so students at Level E are ready to learn this Grade 7 material. This implies that students in Levels E and F are adequately prepared to engage in the Grade 7 Matter curriculum.

In order to determine the percentage of students well-prepared to engage with the conceptual knowledge and skills required by the Grade 7 Matter curriculum, the distribution of students across the various levels was determined for each school type (Table 5). These data are also shown graphically in Figure 3.

Table 5. Distribution of students across competence levels (A=lowest, F=highest)

Level	Regular			Science-oriented High Schools		
	Frequency	Percentage	Cumulative percentage	Frequency	Percentage	Cumulative percentage
F	180	11.3%	100.0%	196	49.0%	100.0%
E	439	27.5%	88.7%	165	41.3%	51.0%
D	331	20.7%	61.2%	23	5.8%	9.8%
C	311	19.5%	40.5%	14	3.5%	4.0%
B	313	19.6%	21.0%	2	0.5%	0.5%
A	23	1.4%	1.4%	0	0%	0%

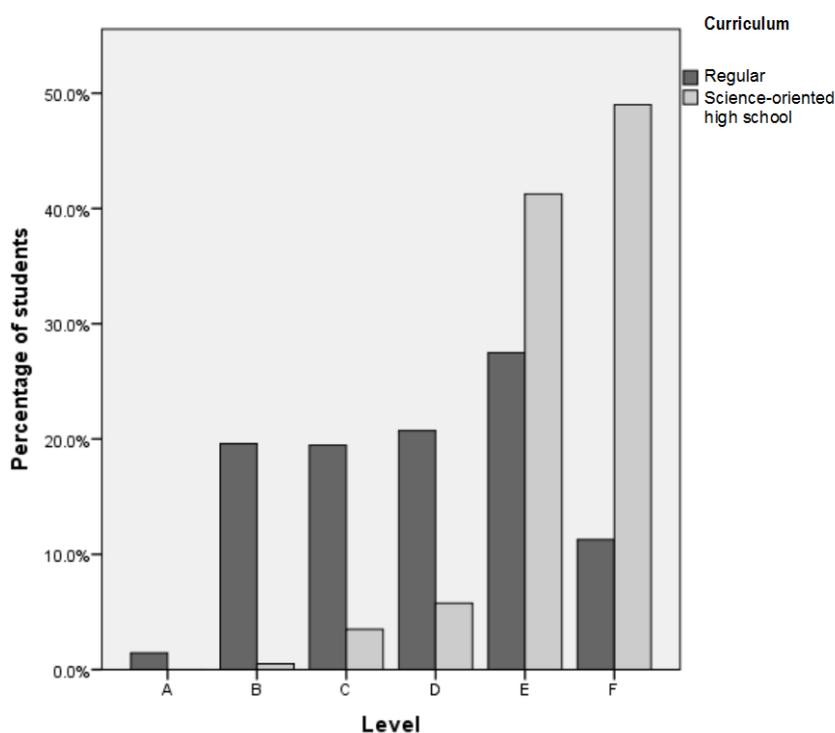


Figure 3. Distribution of students across levels in Regular and Science-oriented High Schools

These data signify that the majority of science high school students are well prepared to engage with the conceptual knowledge and skills required by the Grade 7 chemistry curriculum. Unfortunately, this is not the case for students in

regular schools, where 61% of students tested do not yet have the conceptual knowledge and skills to engage fully in the Grade 7 chemistry curriculum. The danger for these students is that, without the pre-requisites, they will not be able to understand the material presented to them as part of their Grade 7 experience and they will fall further behind their peers. If they are not able to grasp the Grade 7 lessons, they are at risk regarding the demand of subsequent years due to the cumulative nature of science concepts and skills.

It should be kept in mind that the cohort of students represented in this study have not been taught according to the current K-12 curriculum. They are graduates of the Basic Education Curriculum (BEC). The next cohorts of students entering Year 7 through to and including SY 2018-2019 will similarly be graduates of the BEC, and may therefore be similarly disadvantaged in terms of dealing with the demands of Grade 7 Matter under the K-12 curriculum.

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APPENDIX I

BLUEPRINT FOR PRE GRADE 7 MATTER TEST

Strand	Proportion of items	Pre-requisite concepts and skills (as identified by expert group)	Curriculum Links (learning competencies unless stated otherwise)
1.1 Physical states of matter	20%	<ul style="list-style-type: none"> give examples of solids, liquids and gases describe/use properties of physical states of matter 	Grade 3: 2. classify objects and materials as solid, liquid, and gas based on their characteristics
1.2 Properties of substances and mixtures	20%	<ul style="list-style-type: none"> identify whether a mixture is homogeneous or heterogeneous design a method that can separate components of a mixture 	Grade 6: 1. describe the appearance and uses of uniform and non-uniform mixtures 2. enumerate techniques in separating mixtures such as decantation, evaporation, filtering, sieving and using magnet
1.3 Properties of elements and compounds	5%	<ul style="list-style-type: none"> give examples of properties of metals describe/use properties of metals 	<i>Note: although properties of metals are not explicitly listed in the curriculum, they are implied in a variety of learning competencies.</i>
2.1 Atomic structure	5%	<i>Although the concepts that matter consist of elements, atoms, and sub-atomic particles is not a strict pre-requisite for Grade 7, these ideas were included since students coming into Grade 7 with an understanding of these concepts would benefit.</i>	
2.2 Molecular structure	0%		
3.1 Physical and chemical changes	10%	<ul style="list-style-type: none"> describe changes in solid materials when they are bent, pressed, hammered, or cut recognize changes in state (melting, freezing, etc.) 	Grade 3: 4. describe changes in materials based on the effect of temperature Grade 4: 4. describe changes in solid and liquid materials

		<ul style="list-style-type: none"> • recognize that some metals rust • recognize dissolving 	<p>5. describe changes in properties of materials when exposed to certain conditions such as temperature or when mixed with other materials</p> <p>Grade 5:</p> <p>2. investigate change that happen in materials under the following conditions:</p> <p>2.1 presence or lack of oxygen</p> <p>2.2 application of heat</p>
3.2	0%		
Chemical reactions			
4.1	40%	<ul style="list-style-type: none"> • observing • inferring • grouping based on a set of properties • recognizing scientific questions • using lab tools and equipment • reading and recording data • describing • identifying similarities and differences • recognize what scientific inquiry skills are • using diagrams to illustrate processes, equipment, observations, science ideas • drawing conclusions from results • identifying variables • determining whether conclusions follow from results • converting within a scale of measurement e.g., g to mg to kg and mL to L 	<p>Grade 4-6 key stage standards:</p> <p>Essential skills of scientific inquiry – designing simple investigations, using appropriate procedure, materials and tools to gather evidence, observing patterns, determining relationships, drawing conclusions based on evidence, and communicating ideas in varied ways to make meaning of the observations</p>

Science Curriculum Project: progress of students through the science curriculum: a focus on matter (chemistry)

Project Leads: Dr Marlene Ferido and Pam Robertson

Centre Lead: Dr Therese Bustos

Research Lead: Dr Esther Care

Research Officer: Joesal Marabe

Research Team (University of Melbourne): Pam Robertson, Dr Susan-Marie Harding, Masa Pavlovic

Research Assistants: Lalaine Bagui, Rachel Ramirez

Research Team as at September 2015.

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