TEACHING UNDERGRADUATE PHYSICS:
CHANGING PRACTICES IN AUSTRALIA AND VIETNAM

by

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submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy

Deakin University
January, 2014
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Abstract

This study investigated undergraduate physics teaching and learning practices in three Australian universities and three Vietnamese universities to find out basic differences and similarities of the practices between Australia and in Vietnam. The investigation revealed the strengths, weaknesses, challenges, changes, and future directions of undergraduate physics teaching and learning in the Australian and Vietnamese universities. It also determined factors that constrained or enabled quality physics teaching and learning in these universities. The study is important for Australia and Vietnam to improve the quality of teaching and learning tertiary physics.

This study surveyed teaching staff and undergraduate physics students in departments of physics in these universities by using questionnaires and in depth interviews with the physics staff, the students, and several physics education innovators. In addition, the study involved observations of physics teaching and learning practices in lectures, tutorials and laboratories and analysing documentation including course handbooks, physics curricula, subject syllabi, and laboratory manuals. Mixed research methods including both quantitative and qualitative techniques were employed in this study. Triangulation was used to improve the internal validity and reliability of the study.

The study found a range of differences in the current practices between two countries, which includes the structure of undergraduate physics courses, requirements of physics undergraduate degrees, the preparation of incoming students, the availability of teaching and learning facilities and resources, and teaching and learning approaches. The study also found that the universities in both countries have been changing towards more student-centred learning approaches in teaching physics. However, there are constraints that differentially prevent them from successfully implementing interactive and engaging learning approaches, including culture-based constraints, system centralisation, the background of students, and the lack of teaching and learning facilities and resources. Key differences that favoured quality teaching and learning in the Australian universities included the strong research involvement of staff, the commitment to graduate skills and digital resources and infrastructure which was a key factor in driving student-centred teaching and learning arrangements.
Chapter 1. Introduction

As an undergraduate physics lecturer at a Vietnamese pedagogical university, which mainly trains primary school teachers and secondary school teachers, I have experienced many changes and innovations in many aspects of teaching and learning practices that the Vietnamese Ministry of Education and Training (the MOET) has applied throughout the country in recent years. These include changes in structures and the content of curricula, teaching and learning approaches, textbooks, and the move towards a more Western style rather than the Soviet style in university practices.

However, from my teaching experience, undergraduate physics teaching and learning practices in my university in particular, and in many Vietnamese universities in general, are now not much different from the practices of fifteen years ago when I was an undergraduate physics student studying for my Bachelor degree. Therefore, I have always had an ambition to find out reasons why Vietnamese universities and their graduates have regionally and internationally low status and to discover a way to improve undergraduate physics teaching and learning practices in particular, and Vietnamese higher education practices in general.

With the policy of the Vietnamese Government to send academics to study in developed countries, I was awarded a scholarship from the MOET to study a Master of Science Education degree at an Australian institution in 2003. In my minor thesis, which partially fulfilled the degree, I investigated the application of real-life contexts and practical work that Vietnamese secondary school teachers integrated into their teaching. This thesis’ findings showed that these practices were not highly valued in the Vietnamese teaching at secondary school level for many reasons. As part of my master degree, I attended several physics courses in the department of physics and discovered that the structures of the course, the content of physics subjects and the ways that physics knowledge and skills were delivered in Australia were very different from my experience in Vietnam.

Therefore, during that time, I would like to know how a standard subject like physics could be taught differently in Australia compared to Vietnam and that was my
research interest for my further study. Broadly, my study investigates current undergraduate physics teaching and learning practices in three Australian universities and three Vietnamese universities and compares these practices. The aim of this study is to determine major differences and similarities in current undergraduate physics teaching and learning practices between the universities in Australia and the universities in Vietnam. This study also aims to investigate changes, driver for the changes and future directions of undergraduate physics in these universities.

The instrumentation of this study are: (i) questionnaires for physics teaching staff and undergraduate physics students in the departments of physics in these universities in Australia and Vietnam; (ii) in depth interviews with the physics teaching staff, the students, and several physics education innovators in these universities; (iii) observations of undergraduate physics teaching and learning practices in lectures, tutorials and laboratories; and (iv) the analysis of documentation that includes course handbooks, physics curricula, subject syllabi, and laboratory manuals. This study employs mixed research methods which include both quantitative and qualitative techniques and triangulation technique to improve the internal validity of the study.

Findings from this study will inform the current status of undergraduate physics teaching and learning in the Australian and Vietnamese universities. The findings will also reveal changes and future directions of undergraduate physics practices in these universities. Therefore, this study will be a useful reference for the Vietnamese universities to reflect on their undergraduate physics practices from experiences of the Australian universities. This study will also be helpful to the Australian departments of physics because it will reveal strengths and weaknesses in their current undergraduate physics teaching and learning practices.

1.1. Underlying problems

Although the Vietnamese education system has undergone many reorganisations and reforms to improve its quality of teaching and learning in tertiary education, the outcomes achieved to date are somewhat insignificant. Vietnamese universities and their graduates are considered to have low qualifications both inside and outside the country. For example, in a recent national conference held in Ho Chi Minh City on January 5th,
2008 with the participation of representatives from seventeen Vietnamese ministries and nationwide higher education institutes, Deputy Prime Minister - Dr Nguyen Thien Nhan - stated that the quality of higher education in Vietnam remained low and drastic measures were required for a big improvement (Hue University, 2008). In recent years, the MOET and other education organisations have been working to find a way to improve Vietnamese tertiary education. Their aim is to increase the quality of Vietnamese education to a standard of developed countries’ higher education.

For undergraduate physics education practices, a recent report from a project entitled “Observations on Undergraduate Education in Computer Science, Electrical Engineering, and Physics at Select Universities in Vietnam”, conducted by the Vietnam Education Foundation (VEF) and an independent federal agency from the United States of America (the U.S), has reported that the Vietnamese higher education system has many weaknesses, which include:

- Undergraduate teaching and learning practices is ineffective and there is a lack of facilities and resources.
- Undergraduate curricula have too many courses, a large number of requirements and few choices, out-of-date content, an imbalance between theoretical courses and applied/practical courses, and a lack of flexibility to transfer between majors.
- There is a lack of qualified teachers, a low level of academic preparation of teaching faculty, a lack of skills of faculty in modern teaching practices and research, a lack of up-to-date knowledge by faculty in their fields with regard to curriculum and course content, and an increase in staff workload.
- Institutional effectiveness and program and course quality are not based on evaluation of student learning.

(Director, Doughty, Gray, Hopcroft and Silvera, 2006, p. 3)

The project identified some of the challenges that Vietnamese higher education institutes have had to deal with in recent years. Nevertheless, the findings from the project need to be further investigated because the project studies a limited number of universities in Vietnam and draws its conclusions based on opinions and experiences of several educators from the U.S without making comparison with other institutions in developed countries. Therefore, a broader perspective is needed to thoroughly justify those problems in higher education in Vietnam.

In this study, Australian universities are chosen as comparative institutions because for several decades, alongside with the U.S., the United Kingdom (the U.K) and several European countries, the Australian education system, especially its higher
education sector, has been internationally considered as one of the highest quality, effective and efficient education systems in the areas of research, teaching and learning, and training academics and the labour force. A recent University World News analysis ranked the Australian higher education system third in the world (Gerritsen, 2008). Many Australian universities have been internationally recognised as leading universities in term of research and teaching innovation. Particularly, according to the Times Higher Education, there were seven Australian universities ranked in the top 100 world universities in 2008, and the number was eight universities in 2009. Those are the reasons why Australia has become a favourite destination for international students seeking advanced knowledge and experience in many areas. For example, according to Harman (2006) and Dixon and Scott (2008), Australia is the third-largest exporter of higher education after the U.S. and the U.K. and its higher education is also third highest service export industry in Australia with a contribution of over $5 billion each year.

1.2. Research questions

The research problem in this study is embraced in the overarching question of the investigation. The overarching question guiding my study is: “what are potential changes in teaching and learning of undergraduate physics practices in Vietnam, which can be improved from the Australian universities’ experience?”. This study has three specific research questions, which are:

(1) What are major differences and similarities in current undergraduate physics teaching and learning practices between the Australian and the Vietnamese universities?

(2) What are participants’ perceptions of challenges, changes and future directions of undergraduate physics teaching and learning practices in the Australian and Vietnamese universities?

(3) What are the factors that constrain or enable quality physics teaching and learning in Australian and Vietnamese universities, and how might each system improve its practices?
1.3. Thesis outline

This thesis begins with an introduction chapter, in which the rationale of the study is presented. Chapter 2 is literature review, which explores changes and trends in teaching and learning in higher education in recent years. Particularly, chapter 2 aims to develop a broad view of factors that have influenced education practices and how higher education institutions have responded to these influences. Chapter 2 also reviews how physics education and its practices are affected by the changes. The cultural, political and economic differences and the constraints that might affect the improvement of undergraduate physics teaching and learning practices in the universities in both countries will also be discussed in this chapter. Chapter 3 describes the methodology and methods used in this study to answer the research questions. Because of the extent of the study, both quantitative and qualitative research methods are employed to analyse the data collected using questionnaires, in-depth interviews, observations, and the collection of undergraduate physics teaching and learning documentation from the universities in the two countries.

Chapter 4 uses data collected by analysing the documentation from the universities in both countries to investigate differences and similarities between the Bachelor of Science majoring in Physics degree (the BSc PHY) provided in the Australian universities and the BSc PHY provided in the Vietnamese universities. Chapter 5 aims at partially clarifying those similarities and differences by analysing the data collected through the observation of undergraduate physics teaching and learning facilities and resources and the observation of teaching and learning activities in lectures, tutorials and laboratory sessions in the six studied universities in Vietnam and Australia.

Chapter 6 investigates undergraduate physics students’ opinions on teaching and learning practices of physics. This chapter will reveal students’ views about: issues that challenge their learning of physics and how they deal with these challenges; features of undergraduate physics teaching and learning practices, which help them learn physics effectively; and teaching and learning environment in their universities. Chapter 7 investigates perspectives of teaching staff and opinions of several physics education innovators on current undergraduate physics teaching and learning practices and future
directions of the practices in both countries. In particular, this chapter will explore opinions of teaching staff on their own teaching practices, undergraduate physics programs, physics curricula and syllabi, the teaching and learning environment in their universities and departments, and challenges, changes and future directions of tertiary physics. Chapter 8 is conclusions and implications. This final chapter will collect different threads of the investigation of undergraduate physics teaching and learning practices in the Vietnamese and Australian universities. It summarises the findings and draws them together.
Chapter 2. Literature Review

2.1. Introduction

Higher education sector has changed profoundly over few decades as a result of the growth and increasing diversity of the student population, the transforming effect of information and communication technologies (ICTs), the increasing global competition and internationalisation, and increasing attention to the quality and accountability of higher education (Biggs, 2003; Evans and Abbott, 1998; Light and Cox, 2001; Nicholls, 2002; Tennant, Mullen, and Kaczynski, 2010). The development of higher education over the last decade has individually and collectively created changes and refinements to core functions of higher education, including teaching and learning, particularly on “how and what students learn and the way that knowledge, skills, learning and teaching are assessed” (Altbach, Reisberg, and Rumbley, 2009, p. 111).

The majority of higher education institutions in most countries today are under pressure to provide education that is “less abstract”, “discipline-bound” and more relevant to problems and issues found in workplaces, and to deliver professional programs to a wider range of students than in the past (Tennant et al., 2010, p. 8). For current university students, problems and issues in future work contexts are characterised by rapidly changing conditions and work assignments. Hence, in order for students to achieve success in their professional life, higher education must pay attention to develop students’ higher order thinking skills, knowledge, and attitudes. These include creative thinking, the ability to learn independently, and the ability to adjust and adapt to changing conditions (Altbach et al., 2009; Hativa, 2000).

This means that preferred learning outcomes for students completing university education should not only focus on their understanding but also their ability to integrate and apply crucial aspects of their discipline into real life contexts. In other words, teaching is not only an act of facilitating students’ knowledge but also aims at changing students’ conceptions and their understanding of the real world. Outcomes of such teaching should be students who have deeper knowledge and higher level of reasoning (Boulton-Lewis, 1998). In order to achieve those student learning outcomes and hence improve the quality of teaching and learning practices, higher education institutions need
This chapter will briefly review the main factors that have driven changes in higher education during recent years and the conception of effective teaching in higher education. This chapter will also review the challenges and changes that undergraduate physics teaching and learning practices have been facing and several interactive and engaging teaching approaches that have been considered to be effective in physics teaching in Australian universities. In addition, the chapter will provide a brief glance over the Vietnamese education system and its undergraduate physics teaching and learning practices. Finally, differences in cultures, political systems and the state of economies between Australia and Vietnam, which affect the operation of higher education institutions in the two countries will be reviewed.

2.2. Teaching and learning practices in higher education

There are many factors that create challenges and changes in higher education, in which the following factors have been identified by education researchers around the world as main drivers for the changes in higher education in recent years: the growth and increasing diversity of the student population; the transforming effect of ICTs; increasing global competition and internationalisation; and attention to the quality and accountability. These factors will be reviewed in the following sections.

2.2.1. The growth and increasing diversity of the student population

Over the last few decades there has been a rapid increase in the number of students enrolling in higher education institutions. According to an estimation from the Organisation for Economic Co-operation and Development (OECD), there are now around 132 million students enrolling in higher education globally in comparison with 68 million in 1999 (Tennant et al., 2010). In the 1990s only about 15% of secondary school graduates entered higher education but this figure was around 40% in 2003 in many areas (Bigg, 2003). In Australia, for example, during the period between 1989 and 2002, there had been an increase of 70.3% in domestic and overseas student participation in higher education as can be seen from Table 2.1 (Dobson, 2003).
Table 2.1: Enrolments in higher education in all fields of study/education

<table>
<thead>
<tr>
<th>Domestic/Overseas</th>
<th>1989</th>
<th>1993</th>
<th>1997</th>
<th>2001</th>
<th>2002</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>419962</td>
<td>538464</td>
<td>595853</td>
<td>613034</td>
<td>626214</td>
<td>206252</td>
<td>49.1%</td>
</tr>
<tr>
<td>Overseas</td>
<td>21112</td>
<td>37152</td>
<td>62996</td>
<td>112065</td>
<td>124726</td>
<td>103614</td>
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<td>575616</td>
<td>658849</td>
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<td>750940</td>
<td>309866</td>
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<tr>
<td>% Overseas</td>
<td>4.8%</td>
<td>6.5%</td>
<td>9.6%</td>
<td>15.5%</td>
<td>16.6%</td>
<td>33.4%</td>
<td></td>
</tr>
</tbody>
</table>

Source: DEST Aggregated Data Sets

In Vietnam, the number of higher education students also increased from 133,136 in 1987 to over 1.7 million in 2009, with the 2009 enrollments representing thirteen times those experienced in 1987 (MOET, 2009).

The growth in the number of student participation is an opportunity for higher education institutions but also a challenge that create in many issues. The two most important issues that affect higher education practices are the diversity of student population and an increase in the overall student-staff ratio. In fact, universities today are different from traditional universities in term of student population. Particularly, traditional universities’ classes contained highly selected and quite homogeneous students while today university participants vary in terms of age, gender, social-economic status, and their attitude and motivation towards learning (Biggs, 2003; de la Harpe and Radloff, 2008).

The changes in student demographics make higher education institutions, departments and lecturers today face unprecedented problems of adjustment. For example, at the institutional level, it requires the provision of a range of services and supports for students such as the extension of programs, learning assistant courses, and online and various learning resources. At the departmental level, these changes require flexible curricula and syllabi, student learning support services, and tutoring and mentoring programs. More importantly, at the individual level, teaching staff and technical staff have to adjust their teaching and supervising methods by implementing various and flexible interactive engaging (IE) teaching approaches, a variety of assessment methods, and active and friendly teaching and learning environment (Chalmers, 2007).
2.2.2. The impact of information and communication technologies

In recent years, with high speed and low cost, ICTs have been transforming higher education practices. A wide range of ICT elements have been implemented in education at all levels and the use of these technologies is now ubiquitous in education. For example, according to Altbach et al. (2009), some applications of ICTs that are used in education include:

Databases; e-mail; Websites; social networking tools such as chat rooms, bulletin boards, and discussion boards; blogs which are essentially Websites featuring ongoing posts of information, ideas, commentaries, and other content; wikis which is a page or collection of WebPages designed to enable anyone who accesses it to contribute or modify content; Real Simple Syndication which is for subscriptions to online content from preferred sources; podcasts (typically for audio content), online videos, and instant messaging (p. 125).

The two most important changes in higher education practices in which ICTs play an important role are in research and in teaching and learning practices in the classroom. Particularly, ICTs allow researchers to conduct complex calculations from large data sets. Researchers are able to communicate and cooperate with other colleagues from institutions around the world instead of concentrating in a single institution. Researchers can also easily access resources from digital libraries interconnected between institutions and libraries. In addition, higher education institutions are now able to establish joint information systems that link information, resources and issues in research (Balasubramanian et al., 2009). Those utilities of ICTs help researchers to produce better quality research across broader disciplines, contexts and cultures.

In teaching and learning practices in the classroom, it is certainly that ICTs have dramatically changed the way curriculum content is delivered to students and the way students receive the content and interact with their lecturers and peers. According to Oliver (2002), ICTs have had an impact on what students learn, how students learn and when and where students learn. Particularly, with the availability and support of new emerging instructional technologies, curricula in higher educational institutions have been designed to be competent and performance-based. These curricula include the following characteristics:

- access to a variety of information sources;
- access to a variety of information forms and types;
- student-centred learning settings based on information access and inquiry;
- learning environments centred on problem-centred and inquiry-based activities;
- authentic settings and examples and;
- teachers as coaches and mentors rather than content experts.

(Oliver, 2002, p. 2)

These approaches in teaching and learning are different from conventional teaching practices. In the traditional approaches, the teacher is considered an expert at subject knowledge and the teaching mainly focuses on content. In the traditional classroom, student learning is an act of consolidating and rehearsing the content. In contrast, these approaches emphasise a student-centred learning mode which considers teaching as an activity of supporting knowledge construction rather than a process of knowledge transmission, and learning is an active process of constructing knowledge rather than acquiring knowledge (Duffy and Cunningham, 2001). These student-centred approaches are claimed to be successfully supported with a curriculum design based on a wide range of ICTs’ applications.

Also with the availability of ICTs, distance education and e-learning such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration, have now become more popular and applicable for most countries and regions around the world. ICTs have opened up opportunities for many people living in remote areas and in underdeveloped regions to gain access to higher education systems. These opportunities are advantages, but also challenges that require higher institutions in these underdeveloped regions to change their practices in order to improve the quality of teaching and learning.

2.2.3. Globalisation and internationalisation

In recent years, globalisation and internationalisation have become central forces for higher education sector and education in general in changing its practices. Although the terms globalisation and internationalisation are closely related, they refer to two different phenomena. According to the definitions from Altbach (2006),

Globalization is defined as the broad economic, technological, and scientific trends that directly affect higher education and are largely inevitable in the contemporary world. These phenomena include information technology in its various manifestations; the use of a common language for scientific communication; the imperatives of society’s mass demand for higher education and for highly educated personnel; and the “private good” trend in
thinking about the financing of higher education… Internationalization refers to specific policies and programs undertaken by governments, academic systems and institutions, and even individual departments to support student or faculty exchanges, encourage collaborative research overseas, set up joint teaching programs in other countries or a myriad of other initiatives (p. 123).

Thus, globalisation is the catalyst, involving the flow of ICTs, knowledge, people, and economy across borders while internationalisation in higher education is a strategy for higher education institutions to respond to demands caused by globalisation and to prepare a workforce having necessary skills and knowledge to engage in a globalised world (Altbach et al., 2009).

The globalisation and internationalisation in higher education sector offer opportunities for teaching and learning practices and doing research. For example, the rapid development of ICTs has opened up new modes for online learning and distance education, which are accessible for people almost anywhere in the world. Importantly, with worldwide available and accessible resources, educational researchers have opportunities to conduct quality studies on educational practices across nations. The flow of people across borders also creates opportunities for higher institutions to attract more full-fee paying international students and also talented academics.

However, besides those opportunities, higher education institutions are now facing many changes and challenges. One of the major challenges that higher education institutions are now facing is serious competition from foreign institutions. This competition is described by Altbach et al. (2009) as “highly unequal”, especially for institutions from undeveloped and developing countries. According to Altbach et al. (2009, p. 32), with the advantage of budget, resources and academics, “the elite universities in the world’s wealthiest countries hold a proportionate influence over the development of international standards for scholarship, models for managing institutions, and approaches to teaching and learning”.

As a result, the higher education sector in most countries should take action and initiate changes at institutional level as well as governmental education policies to sustain and advance their teaching and learning practices. Particularly, investment should be focused on the availability of resources such as teaching and learning
materials, educational technologies, teaching, learning and research facilities, and high qualified academics. Higher education institutions in undeveloped countries and developing countries should also cooperate and have joint-programs with high ranked institutions in the developed world in order to participate in globalised and internationalised contexts of education. More importantly, creating an equal and internationally friendly environment and international agreements and frameworks is a vital driving force for institutions in these undeveloped and developing countries to take part in the global education agendas.

2.2.4. Accountability and quality assurance

The increased international and global competition among higher education institutions has increased the pressure to sustain and improve their efficiency, effectiveness and public accountability. Today one of the important features of universities worldwide is the move towards more accountability and stronger quality assurance processes. Higher education institutions throughout the world are working to design and implement effective quality assurance mechanisms and systems (Chalmers, 2007; Harman, 2000; Tennant et al., 2010). For example, Harman (1996) stated that:

Quality issues dominate the higher education debate in many countries, as ministers, bureaucrats, employers and business interests become increasingly concerned about the outputs of higher education institutions and the suitability of graduates to meet the needs of employers. Many people question whether their societies are getting real value for their massive investment in higher education and urge the adoption by governments of mechanisms to achieve more control over the work that higher education institutions do. Quality and accountability thus have become key elements in the efforts of many countries to become and remain internationally competitive in a world where interdependence in trade is rapidly growing (p. 1).

Accountability and stronger quality assurance processes that higher education institutions in many countries have been developing include “the maintenance and improvement of levels of teaching, learning, research and scholarship; improvements in the quality and adaptability of graduates; how to define and measure quality; management approaches that are likely to improve outcomes from universities and colleges; the use of benchmarking and performance indicators; and how to convince stakeholders that institutions and systems are doing a competent job in ensuring quality outputs” (Harman, 1996, p. 1).
In the context of globalisation, higher education institutions in undeveloped and developing countries are under more pressure than institutions in the developed world. The inadequacy of educational infrastructure, the lack of teaching and learning facilities, equipment, and resources, and the lack of high quality teaching and training staff are factors that lower the standard of their teaching and learning practices. Hence, it is difficult for those institutions in developing regions to assure their quality. On the other hand, institutions in developed countries have good teaching and learning conditions and supports to assure and improve the quality of their teaching and learning practices, and hence their graduates. As a result, higher education institutions in the developing world need to take appropriate actions such as improve teaching and learning facilities and resources, restructure curricula and courses, train their academics, and give full supports for their staff and students in order to raise their standard of education practices.

2.2.5. Effective teaching and learning practices in higher education

In traditional universities, teaching is generally considered as a process of transmitting subject knowledge to students through lectures while assessment is a process of measuring how well students are able to repeat knowledge received from those lectures and from textbooks (Altbach et al., 2009). This knowledge-centred teaching mode has been largely reported to be ineffective in helping students develop a more scientific view and conceptual understanding of subject content.

In today’s universities, the main purpose of teaching is to prepare students for their adult life, particularly for their professional life. Teaching approaches are more student-centred with the view that learning just occurs when students construct knowledge by themselves (Dykstra, Boyle and Monarch, 1999). In contrast with teacher-centred learning approaches, many studies show that student-centred approaches to teaching make students more active in their learning process by actively engaging themselves in learning activities (Carini, Kuh and Klein, 2006; Mulhall and Gunstone, 2007). In a student-centred teaching and learning approach, there is a growing consensus that teaching is a process of “mentoring, guiding, coaching and supporting the learner” (de la Harp and Radloff, 2008, p. 25).
According to the Guidelines for Effective Teaching from the University of Auckland (2004, p. 1), “effective teaching should be research-based, innovative, challenging, responsive to the needs of diverse learners, and underpinned by sound disciplinary and pedagogical expertise. Effective teaching enables students to reach their highest appropriate level of learning through supporting them in taking responsibility for their own learning”. It is certain that making students learn effectively and develop other skills and attitudes depends on many factors. For example, Chickering and Gamson (1987) developed seven principles of good teaching and learning, which they include several factors contributing to good teaching. These principles are:

1. Encourages contact between students and faculty: Faculty concern helps students get through rough times and keep on working. Knowing a few faculty members well enhances students’ intellectual commitment and encourages them to think about their own values and future plans.
2. Develops reciprocity and cooperation among students: Good learning, like good work, is collaborative and social, not competitive and isolated. Working with others often increases involvement in learning. Sharing one’s own ideas and responding to others’ reactions sharpens thinking and deepens understanding.
3. Encourages active learning: Students do not learn much just by sitting in classes listening to teachers, memorising pre-packaged assignment, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences and apply it to their daily lives.
4. Gives prompt feedback: Students need appropriate feedback on performance to benefit from courses. When getting started, students need help in assessing existing knowledge and competence. In classes, students need frequent opportunities to perform and receive suggestions for improvement. At various points during college and at the end, students need chances to reflect on what they have learned, what they still need to know, and how to assess themselves.
5. Emphasises time on task: Learning to use one’s time well is critical for students and professionals alike. Students need help on learning effective time management.
6. Communicates high expectations: High expectations are important for everyone. Expecting students to perform well becomes a self-fulfilling prophecy when teachers and institutions hold high expectations of themselves and make extra efforts.
7. Respects diverse talents and ways of learning: Students need the opportunity to show their talents and learn in ways that work for them (p. 3).

In general, these principles consider good teaching practices to be the ones that encourage the active involvement of students in their learning activities. In order to facilitate students’ active learning, appropriate teaching strategies in classrooms are
considered the most important aspects of improving student performance (Schacter and Thum, 2004). Therefore, the role of instructors is important factor responsible for the quality of student learning, which has been identified by extensive studies over few decades (Haycock, 1998; Jordan, Mendro and Weerasinghe, 1997; Rivkin, Hanushek and Kain, 2001; Sanders and Horn, 1995).

In addition, instructing students to have good learning strategies inside and outside classrooms is also very important in helping students learn effectively. For example, according to Donald (as cited in Hativa, 2000), students’ learning occurs both in classrooms and outside of classes as he stated that:

The learning environment of our students, however, consists of the entire campus, and with the advent of the Internet, increasing extends beyond campus. This means that learning experiences are increasing variable. On campus, students will spend less than three hours per week in any given classroom, and other venues such as the library, laboratory, cafeteria, work or field placements, or the student’s own room acquire greater importance as learning settings (p. 11).

Nevertheless, students’ learning in a classroom context is important as it provides “beneficial background knowledge and assignments for learning outside class, and to motivate and guide students in their learning” (Hativa, 2000, p. 12). Knapper (2004, p. 1) also states that teachers have a special role in “motivating students, providing guidance on learning strategies, offering feedback on students’ performance, and generally serving as “validators” of students’ own learning efforts and accomplishments”.

Findings from research on teaching and learning practices in higher education over few decades have suggested that an effective university teacher should possess an in-depth understanding of a wide range of pedagogical approaches, of the principles which support student learning, and the ability to select and apply different teaching approaches in appropriate contexts (The University of Auckland, 2004). Specifically, an effective teacher should embrace essential components which include command of the subject, clarity, enthusiasm, ability to stimulate interest and motivate students, and connections between research and teaching (Elton, 1998; Feldman, 2007).

Kane, Sandretto and Heath (2004, p. 292) developed a model of effective teaching that has similar dimensions, which was based on analysis of their study: An
investigation into excellent tertiary teaching: Emphasising reflective practice. This model of effective teaching in higher education is shown in Figure 2.1.

According to this model, an effective teacher should have good knowledge about teaching materials. The second dimension in this model is teachers’ skills which include clarity, organisation, motivation, and preparation. These pedagogical skills of university teachers are essential in assisting and enhancing student learning (Kane et al., 2004). Building relevant interpersonal relationships with students such as caring about the students’ needs, respect for students, and understanding what and how they think is also one of the central factors in helping students achieve successful learning in higher education (Kane et al., 2004; The University of Auckland, 2004).

The fourth dimension is the connection between teaching and research. Most studies on the relationship between research and effective teaching conclude that “teaching excellence is enhanced by the ways in which their research informs their teaching, which in turn informs their research” (Kane et al., 2004, p. 297). In fact, it is likely that when lecturers conduct research in the fields related to their teaching, they would have in-depth knowledge on what they teach. Their research expertise would also help students see the meaningful aspects of learning physics by relating the knowledge
to research applications. The last dimension in this model is the personal characteristics of an effective university teacher. These characteristics include: positive self-regard, self-esteem, energy, enthusiasm, positive view of others, being sociable, gregarious and friendly, a sense of humour, and agreeable attribute, which are considered as key influences in supporting student learning.

At the hub of the teaching excellence wheel is reflection, which is defined as “an active, persistent, and careful consideration of any belief or supposed form of knowledge in light of the grounds supporting it and future considerations to which it tends” (Dewey, 1993; cited in Kane et al., 2004, p. 300). Reflective practice as a process of ongoing self-evaluation and inquiry is essential in helping teachers to identify and eliminate weaknesses of teaching process and ineffective practices. Therefore, the reflective process can be considered as an effective way to improve teachers’ characteristics and their teaching practices (Hativa, 2000).

2.2.6. Summary

This section has reviewed the impact of some global issues on higher education institutions. Higher education institutions in most countries have experienced profound adjustments and changes in their institutional policies, courses, curricula, teaching and learning approaches, management processes, and student supports and services with the aims of improving the quality of teaching and learning practices in their institutions.

Higher education institutions react to the growth and increasing diversity of the student population by adjusting their curricula and courses to provide a wide range of services to accommodate all student needs. The development of ICTs provides higher education institutions opportunities to implement online teaching and learning, online and distant courses, and online resources. ICTs also provide opportunities for teaching staff to use student-centred learning approaches in their instructions by integrating technologies in their lectures and providing learning resources that students are able to access outside the boundary of classrooms.

Globalisation and internationalisation bring opportunities as well as challenges to higher education institutions around the world. Particularly, it is an opportunity for the institutions to improve their quality of teaching practices and research to meet
international education standards because globalisation and internationalisation connect institutions around the world together. Globalisation and internationalisation also foster the flow of technologies, knowledge, research, resources, and people among institutions around the world. However, they also create challenges for higher education institutions in their process of improving the quality of teaching and learning practices, especially for higher education institutions in undeveloped and developing regions. Therefore, the management process of insuring the quality of teaching and learning practices in higher education institutions becomes very important in this globalisation context.

The outcomes of those movements on higher education also change the way curriculum content is delivered in the classroom in order to ensure the quality of teaching and learning practices. Traditional teacher-centred teaching approaches are in most cases not suitable to train the future labour force which is required to have not only knowledge but also other skills and abilities. Therefore, the role of teaching staff is important in making the change from teacher-centred to student-centred learning in classroom practices. In addition to having good subject knowledge, teaching staff are also required to have skills, enthusiasm, and pedagogical abilities to successfully implement student-centred learning approaches in their teaching practices.

2.3. Challenges and changes in tertiary physics teaching and learning

Physics is considered a very important subject in most developed countries such as Australia, the U.S., and the U.K. It is not only a fundamental science that is a foundation for understanding other science subjects and for explaining natural phenomena ranging from the microscopic to macroscopic world, but is also a major contribution to the development of technologies and to the economy of a nation. In its subject benchmark published by the U.K. Quality Assurance Agency for Higher Education (2008) and the Report of the Inquiry into Undergraduate conducted by the Institute of Physics (2001), both strongly affirm that physics plays an important role in the U.K. scientific culture. Physics is considered as the core of knowledge for understanding of all aspects of nature and physics graduates play a major role in the U.K. economy and contribute wealth and health to the nation.
Concerning the importance of the subject, there has been a substantial amount of research conducted around the world on the effectiveness of delivering the subject’s contents to students, and on supporting students to become more interested in physics and physics related subjects. In the U.S., project SPIN-UP (Strategic Programs for Innovations in Undergraduate Physics) organised by the National Task Force on Undergraduate Physics was performed among twenty three successful departments to answer an intriguing question: Why during the 1990s, when students numbers in physics were falling all across the US, did some departments have thriving programs? (Hilborn, Howes and Krane, 2003).

In the UK, the Institute of Physics (IOP) made a Survey of Undergraduate and Post Graduate Views in 2000 to enquire about key issues facing undergraduate physics. In 2003, the Australian Universities Teaching Committee launched a project on tertiary physics learning and teaching in Australia titled Learning Outcomes and Curriculum Development in Physics. This project was conducted across thirty four groups or departments who teach tertiary physics in Australia. The aim of this project was to reveal how tertiary physics teaching practice was responding to several issues including multidisciplinary areas, new technologies, student background and expectations, employment, career advice, industry input to the curriculum, teaching for engineering and the biosciences, staffing, and inputs to teacher training (Mills, Sharma, Mendez and Pollard, 2005).

Most research findings show that physics education has been facing challenges and changes. In Australia, for example, when responding to the question “What challenges has your department faced in teaching and learning in the last 3-5 years?” the major challenges that most physics departments responded are:

1. declining staff numbers and the general downsizing of departments
2. the inability to upgrade/upkeep laboratory/IT facilities and laboratory staff
3. counteracting the decline in student numbers
4. the loss of traditional service teaching and the need to find new ones
5. the amount of degree and subject restructuring that has been required
6. the poor mathematical (and physics) background of incoming students
7. the increased teaching load on staff

(Mills et al., 2005, p. 8)

In the US, Thacker (2003) identified a number of factors causing changes in the teaching of physics, which were: “the results from education research; technology as a
teaching tool; decline in the number of students choosing physics as a major field of study; and concerns about the physics content knowledge of different groups of students with particular career goals” (p. 1834). As discussed in section 2.1, the issues that physics education has been facing are mostly in line with the changes and challenges that higher education has been experiencing in the last several years. These issues are: the ineffectiveness of traditional teacher-centred learning approaches; the decline in the number of students enrolling in physics; the change in student demographics; the flexibility of physics curriculum to suit students’ needs; and the impact of ICTs on physics education. These challenging issues will be reviewed in this section.

2.3.1. Traditional undergraduate physics teaching and learning approaches

In a traditional classroom, the main method of teaching is often the transmissive mode in which lecturers present physics concepts from textbooks, solve example problems and occasionally perform demonstrations while students listen, take note and sometimes raise questions or make comments (Cahyadi, 2007; Light & Cox, 2001). This traditional teaching and learning approach in physics is predominantly based on lectures with little or no student involvement, laboratories with cookbook instructions, manipulation of formulae, and examinations usually focusing on quantitative algorithmic problem solving procedures (Hake, 1998; Welzel, 1997). Arons (1997) indicates that physics homework, exercises in physics textbooks and questions in examinations focus on calculation and numerical results but not on conceptual understanding. Osborne (1990, cited in Mulhall & Gunstone, 2007) states that this teaching mode seems to assume students develop an understanding of the physics concepts through successfully solving algorithmic problems.

This traditional instruction has been widely reported to be ineffective in helping students develop a more scientific view and conceptual understanding of physics (Biggs, 2003; Mulhall & Gunstone, 2007; Pundak & Rozner, 2008; Redish, Saul and Steinberg, 1998; Welzel, 1997). During the last few decades, there has been substantial research in education which concentrates on dealing with this ineffectiveness (Welzel, 1997). Most research has reported that traditional teaching approaches fail to rectify various physics misconceptions among students, regardless of the effort of their lecturers (Cahyadi, 2007; Hake, 2005). More recently, much research on undergraduate physics teaching
and learning practices has found that students in lecture-based format show “a lack of solid conceptual understanding of physics” and many of them are weak in quantitative problem solving skills (Thacker, 2003, p. 1836). Students usually get confused about the basic concepts of mechanics, optics, heat and thermodynamics, and electricity and magnetism (Redish et al., 1998).

Recent research in physics education has shown that the teaching approaches that improve students’ understanding of physics are generally involved in focusing students on qualitative understandings and discussions (Mulhall & Gunstone, 2007). Generally these approaches involve recognising that students predominantly develop their own system of physical conceptions prior to entering formal physics education (Dykstra et al., 1992; Welzel, 1997). A large amount of research has demonstrated that many students’ understandings of physics concepts seem to conflict with physicists’ views or in other words, students develop misunderstandings of physics concepts (Larkin, 1983; Snyder, 2000). These misunderstandings or misconceptions in physics students present a significant obstacle to effective physics learning. Redish et al. (1998) assert that students’ own physics concepts are often difficult to change. As a result, effective physics teaching approaches should address students’ misconceptions of physics concepts by considering that students are coming to lectures with their preconceptions of physics knowledge. These teaching approaches provide appropriate learning activities that induce most students to develop a good functional understanding of basic concepts.

2.3.2. The decline in the number of physics students

For the last few decades, the decline in the number of students enrolling in physics courses and the changing nature of students has a large impact on teaching and learning of the subject. According to Dobson (2006), while the total number of students enrolled in Australian education during the period of 1989 to 2002 increased by 70.3%, students enrolled in science courses experienced only an increase of 37%. Furthermore, he also showed that although the total number of students enrolled in science courses increased 37% during this period the number in physical/material science decreased by 25.1% during this time. Mills et al. (2005) also report that while the total university enrolment has rapidly increased over the past ten or fifteen years, the number of students enrolling in university physics courses has not experienced a proportionate increase.
Figure 2.2 shows that the number of students studying in third year physics programs dropped sharply in the period 1994 to 2001.

![Graph showing the number of third year physics students in Australian Universities from 1963 to 2002](image)

**Figure 2.2:** Third year physics students in Australian Universities 1963 – 2002 (Jennings et al. 2003, cited from Mills et al. 2005, p. 9)

Similarly, Figure 2.3 shows the number of U.K. first-year full-time entrants to first degrees at universities in sciences, mathematics, and electrical and electronic engineering between 1985 and 2000. The break in the graph is related to a change in the way data was collected over 1994 to 1995. As can be seen from the figure, the number of the students did not experience an increase as do other subjects.

![Graph showing the number of first-year full-time entrants to first degrees in sciences, mathematics, and electrical and electronic engineering](image)

**Figure 2.3:** The number of first-year full-time entrants to first degrees at universities in sciences, mathematics, and electrical and electronic engineering 1985/1986 – 1999/2000 (Source: USR 85/86-93/94 and HESA 94/95-99/00, cited in IOP 2001, p. 17)
Actually, during the period of 1996 to 2001, there had been a decrease of 10.3% in the number of students studying physical science subjects as shown in Table 2.2.

Table 2.2: Higher education students by subject of study 1996/7-2001/2

<table>
<thead>
<tr>
<th>Subject of study</th>
<th>1996/7</th>
<th>2001/2</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td></td>
<td>Percent</td>
</tr>
<tr>
<td>Biological sciences</td>
<td>81,750</td>
<td>94,560</td>
<td>12,810</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>74,496</td>
<td>66,845</td>
<td>-7651</td>
</tr>
<tr>
<td>Mathematical sciences</td>
<td>19,908</td>
<td>21,800</td>
<td>1892</td>
</tr>
<tr>
<td>Sub total</td>
<td>176,154</td>
<td>183,205</td>
<td>7051</td>
</tr>
<tr>
<td>All other (non-science)</td>
<td>1,580,025</td>
<td>1,903,670</td>
<td>323,645</td>
</tr>
<tr>
<td>All students</td>
<td>1,756,179</td>
<td>2,086,875</td>
<td>330,696</td>
</tr>
</tbody>
</table>

Source: HESA, Table 2e, various years. (http://hesa.ac.uk)

Consequently, these worldwide declines in the number of students enrolled in undergraduate physics courses have triggered educational researchers to study causes of this problem and strategies to make students become more interested in physics and physics related subjects. In Australia, Mills et al. (2005) in the project Learning Outcomes and Curriculum Development in Physics has suggested that possible reasons behind these declining enrolments are:

- *physics has not been an attractive discipline for female students;*
- *international students in the main do not choose to do science;*
- *physics is traditional being seen as being both difficult and mathematically-based;*
- *there are a wider range of courses that students may choose, which may have origins in physics, for example, space engineering, photonics in engineering, computer visualisation in IT* (p. 8).

In the U.S., the project SPIN-UP was set up in 2001 just to study how some physics departments in the U.S. still experienced an increase in the number of students enrolled in their physics courses while the total trend of the enrolment was decreasing (Hilborn et al., 2003). The findings of the project showed that these departments all had strong leadership, commitment to improving the undergraduate program, a well-developed curriculum, opportunities for informal student-faculty interactions, and a strong disposition towards continuous evaluation and experimentation.

These types of research are very helpful for higher education institutions and physics departments in term of improving their undergraduate physics teaching and
learning practices in order to attract more students enrolling in physics courses. According to Thacker (2003), the improvement should focus on the implementation of research-based modified curricula, the incorporation of new technologies into their teaching methods, and the integration of ‘real life’ physics, conceptual physics and practical work into physics lessons.

2.3.3. Changing nature of students

Among other factors, understanding characteristics of students such as students’ background and their learning motivation plays a vital role in helping them learn more effectively (Jonas-Dwyer and Pospisil, 2004; Mills et al., 2005). In contrast with quite homogeneous previous student generations, in today’s universities, there is variety in students’ backgrounds, ages and expectations.

According to Oblinger (2003), students coming to universities today may include a seventeen-year-old high school student who has a good knowledge of ICTs, a twenty-six year-old college student with different expectations of customer service, or a forty-year-old working mother who because of time restriction, would like to get her degree via e-learning. To illustrate, table 2.3 shows the diversity of ages of students enrolled in Australian higher education institutions from 1999 to 2003. As can be seen from these statistics, Australian lecturers now experience a range of students with all ages coming to universities, in which generation Y or “the Millennials” as defined by Oblinger (2003) – students born in or after the year 1982 – would be the majority of students in coming years.

Table 2.3: Student enrolments by age group, 1999-2003 (AVCC, 2005)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Generation</th>
<th>% All Student Enrolments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1999</td>
</tr>
<tr>
<td>&lt;=19</td>
<td>Millennial</td>
<td>27.0%</td>
</tr>
<tr>
<td>20-24</td>
<td>Mix of Millennial &amp; X-Generation</td>
<td>-</td>
</tr>
<tr>
<td>20-24</td>
<td>X-Generation only</td>
<td>33.1%</td>
</tr>
<tr>
<td>25-29</td>
<td>X-Generation only</td>
<td>13.5%</td>
</tr>
<tr>
<td>30+</td>
<td>Mix of Baby Boomers &amp; X-Generation</td>
<td>26.3%</td>
</tr>
</tbody>
</table>
Higher education institutions have also experienced a rapid increase in the number of women enrolled in universities overall, and in science in particular over the last two decades. From 1989 to 2002, the total number of females enrolled in universities increased by over 80% in comparison with a 59% increase in male enrolments (Table 2.4).

Table 2.4: Enrolments: All fields of study/education 1989 - 2002 by sex

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Female</td>
<td>229790</td>
<td>307630</td>
<td>358669</td>
<td>399222</td>
<td>415422</td>
</tr>
<tr>
<td>Male</td>
<td>211284</td>
<td>267986</td>
<td>300180</td>
<td>325877</td>
<td>335518</td>
</tr>
<tr>
<td>Total</td>
<td>441074</td>
<td>575616</td>
<td>658849</td>
<td>725099</td>
<td>750940</td>
</tr>
</tbody>
</table>

| % Female | 52.1% | 53.4% | 54.4% | 55.1% | 55.3% | 59.9% |

<table>
<thead>
<tr>
<th>Growth 1989 - 2002</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>185632</td>
<td>80.8%</td>
</tr>
<tr>
<td>Male</td>
<td>124234</td>
<td>58.8%</td>
</tr>
<tr>
<td>Total</td>
<td>309866</td>
<td>70.3%</td>
</tr>
</tbody>
</table>

Source: DEST Aggregated Data Sets

Moreover, much of the growth in the number of university enrolments has been contributed by overseas students, as shown in Table 2.5. The number of overseas students increased from 4.8% in 1989 to 16.6% in 2002.

Table 2.5: Enrolments: All fields of study/education 1989 - 2002 by domestic & overseas students

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>419962</td>
<td>538464</td>
<td>595853</td>
<td>613034</td>
<td>626214</td>
</tr>
<tr>
<td>Overseas</td>
<td>21112</td>
<td>37152</td>
<td>62996</td>
<td>112065</td>
<td>124726</td>
</tr>
<tr>
<td>Total</td>
<td>441074</td>
<td>575616</td>
<td>658849</td>
<td>725099</td>
<td>750940</td>
</tr>
</tbody>
</table>

| % Overseas | 4.8% | 6.5% | 9.6% | 15.5% | 16.6% | 33.4% |

<table>
<thead>
<tr>
<th>Growth 1989 - 2002</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>206252</td>
<td>49.1%</td>
</tr>
<tr>
<td>Overseas</td>
<td>103614</td>
<td>490.8%</td>
</tr>
<tr>
<td>Total</td>
<td>309866</td>
<td>70.3%</td>
</tr>
</tbody>
</table>

Source: DEST Aggregated Data Sets

These changing natures of university students have caused a profound impact on curriculum designs, programs and teaching strategies in higher education. The diversity of student backgrounds and the increase in overseas students produce a greater diversity of expectations (Mills et al., 2005). This diversity of these incoming students may provide great advantages because of their ability to use ICTs and to work collaboratively. On the other hand, this may create an imbalance between students’ expectations of their learning environment and what they find in universities today. As a result, to operate effectively, higher education institutions need to take into account
these characteristics of today’s students in designing courses, curricula, programs, and providing services (Oblinger, 2003).

In Australia, according to Mills et al. (2005, p. 18), “universities are already responding by providing a wider range of physics courses, greater variety of learning activities and by gathering information about the student body”. For example, many Australian universities provide a variety of learning activities such as exploratorials, workshop tutorials and the conceptual understanding program in physics. These approaches are usually termed Interactive Engagement (IE) methods, which use group work and enquiry-based learning to provide a better learning environment for female students and also enhance learning experiences for all students.

The study on tertiary physics teaching and learning in Australia by the Australian Universities Teaching Committee made recommendations for physics departments and physics teaching staff to teach undergraduate physics effectively in the context of the changing nature of students as:

- Physics staff include in the curriculum learning activities that cater for a variety of learning styles and contemporary technology.
- Physics staff recognise and value diversity of student background, such as previous physics and maths studies, work experience, gender and cultural background in designing curriculum.
- Physics staff acknowledge the competing demands in students’ time, including part time work, when designing learning and assessment tasks.
- Physics staff communicate their expectations of students clearly and explicitly.
- Physics department involve younger academics and consult students in teaching and learning decision-making.

(Mills et al. 2005, p. 18)

2.3.4. The flexibility of physics curricula to suit students’ needs

In recent years, physics departments have been forced to redesign and create courses for particular groups of students. The reasons behind these changes are the results of many factors such as the loss of traditional service teaching, the growth in multidisciplinary courses and subjects, and the training of pre-service and in-service physics teachers. These restructurings of undergraduate physics courses aim to broaden physics context and applications and seek to enrich the students’ appreciation of physics to their chosen disciplines (Mills et al., 2005).
In Australia and other developed countries, service teaching, which according to Sharma et al. (2009) is the teaching of physics-based subjects to students enrolling in other degree programs, is one of major factors contributing finance and sustainability to physics departments. The most common service subjects are those for engineering, biomedical/bioscience, physical science and environmental science.

However, in recent years, service teaching opportunities have declined in many institutions. In response to this decline, physics departments have identified and developed courses and curricula particularly for students intending careers in different fields (Thacker, 2003). Units designed for health science students are a good example. In these physics units, students spend more time on fluid flow, optics and waves because these areas of physics knowledge are related to many health science applications such as the modelling of the circulatory system, the structure and physics principles of eyes, and the nervous system (Thacker, Diaz and Eligon, 2007).

Recently in 2009, the report titled *Forging New Directions in Physics Education in Australian Universities: Service Teaching* supported by the Australian Learning and Teaching Council has identified good practices in service teaching in physics. The most important factors that university academics highly appreciate when they responded to the question “What constitutes good practice in teaching a subject designed for non-physics majors?” were:

- Builds on students’ experience;
- Context/site of application of the physics has meaning for the student;
- Recognises the future use to which students may apply the principles learned;
- Contexts employed have explicit relationships with major area.

(Kirkup & Mendez, 2009, p. 10)

In addition, to sustain service teaching in physics, the Australian Universities Teaching Committee also makes a recommendation for the AIP and physics departments in Australia to implement in their teaching practices. This recommendation is:

Physics departments and the AIP pursue strategies to ensure that service teaching to engineering, biomedical sciences and other disciplines, is valued and promoted, by means which include effective inter-department or inter-departmental teaching liaison groups, dialogue with Deans of client departments, sharing of good practice teaching syllabi and materials between physics departments, engaging in or having representation at engineering education conferences, and discussion with professional societies.

(Pollard, Sharma, Mills, Swan and Mendez, 2005, p. 38)
Another aspect that makes physics departments modify their subject content in existing majors is the growing number of multidiscipline courses and subjects. In the context of decline in the number of students enrolled in physics courses, the loss of service teaching and the downsizing of many physics departments, creating more multidisciplinary courses and subjects is necessary in order to attract more students to study physics. For example, one of the heads of physics departments has expressed when responding to the survey that “*multidisciplinary programs intended outcomes are to stabilise the budgets of physics departments by offering a more marketable degree than just physics*” (Mills et al., 2005, p. 31).

To be successful in implementing multidisciplinary courses and subjects, several departments should work cooperatively together in order to provide enough subjects, practical facilities and resources required for students. As an example, departments of physics, chemistry, biology and engineering jointly cooperate to offer degrees in nanotechnology, photonics, biotechnology, environment science and medical physics (Sharma et al., 2009). Today about 50% of physics departments in Australia have been successfully delivering nanotechnology courses to students (Mills et al., 2005).

Consequently, physics departments should allocate the balance of resources between service/multidisciplinary teaching and teaching physics majors (Sharma et al., 2009). Physics curricula and physics content should be also modified to be relevant to the degrees offered. Besides, as discussed above, physics departments need to support and encourage their teaching staff to have good teaching strategies and approaches in teaching service/multidisciplinary subjects in order to improve the quality of student learning.

In these groups of concerns, pre-service teachers and in-service teachers have received a lot of attention from physics educational researchers as well as from physics departments. Pehkonen, Koponen and Mantyla (2009) states that “a physics teacher is at the same time an expert in physics as a discipline and in its didactics” (p. 347). Therefore in teachers’ training, emphasising the teachers’ content knowledge of physics is as equally important as the teachers’ pedagogical content knowledge. However much of research in education has shown that programs for training pre-service and in-service physics teachers are inappropriate. For example, according to Thacker (2003, p. 1846),
“students often do not gain a solid conceptual understanding of physics concepts and instructors do not model teaching methods that could be used in primary and secondary schools”.

As a result, there is the need for redesigning physics curricula as well as physics programs to place emphasis on not only physics content knowledge but also on pedagogical knowledge. These courses and programs need to be more “inquiry-based, hands-on and interactive and include more cooperative learning” (Thacker, 2003, p. 1840). Realising the importance of this issue, a larger number of physics departments in Australia have taken action in more proactive ways. In Mills et al. (2005) report, in response to the question “How has your own department adapted to the changes to high school physics?”, about 50% of the physics departments stated that they provided a variety of courses and development days and workshop for in-service physics teachers, and about 30% of the departments connected with physics school teachers via networks like the AIP, Physics Olympics and regular school visits.

2.3.5. Technology as a teaching tool

The use of computer-based and multimedia instructional materials in university physics courses has increased dramatically in the last decade. For example, some of these educational technologies which have been used in physics instruction are:

- Classroom management software: allowing lecturers to post course documents, resources, student grades online, and to communicate with students via email or online-conference (Tennant et al., 2010; Thacker, 2003).
- Homework delivering systems and online homework: supplying physics lecturers with databases of potential homework problems that students can perform online with immediate feedback (Krusberg, 2007).
- Computers in undergraduate laboratory and simulations: the computer is a tool, just like a microscope or models of atoms and molecules are, for helping students learn complex and abstract science concepts (Berg, 1997).
- Online courses and distance learning: allowing lecturers to communicate with off-campus students and present materials online or via video conferencing.
The emergence of educational technologies in physics education is having a profound impact on all areas of physics instruction. According to Berg (1997), educational technologies are becoming useful tools in physics instruction as he said:

Exciting new technologies are coming into the Physics laboratories, e.g. Microcomputer based laboratory (MBL), various spreadsheets (Mathcad and others), simulation software such as Interactive Physics which move on the boundary of experimental and theoretical physics, measurements on real life objects such as airplanes and sports heroes by linking video camera recordings or existing tapes/dicks with MBL, possibilities of testing hypotheses on data from data bases available on the Internet. They provide unique opportunities for doing physics on real objects with friction rather than on idealized objects (p. 1).

Besides helping to eliminate tedious tasks such as measuring and charting data points one by one, the graphing of data and calculations by using various spreadsheets and other computer-based technologies such as data-logging and simulations are important for modelling science (Ng & Gunstone, 2003). Hofstein and Lunette (2002) also stated that to provide meaningful experiences that are often not possible with real objects, simulations can increase students’ involvements with concepts and systems in a dynamic and interactive manner. In physical science, for instance, simulations of the Bohr model of nucleus, nuclear or chemical reactions, the kinetic-molecular model, or the nature and flow of electric charge can increase students’ conceptual understanding of physics.

2.3.6. Summary

Although the curriculum content of physics has not changed much over few decades, there have been movements within higher education sector which create changes to the way that we teach undergraduate physics. These changes have arisen from: the ineffectiveness of traditional instruction in improving the quality of student learning; the decline in the number of physics students; the changing nature of students studying physics; the requirement of designing new courses for particular groups of students; and the impacts of ICTs. The changes in undergraduate physics include these following aspects:

- Programs: providing more new service courses and multidisciplinary areas to deal with the diversity of students and to attract more students enrolling in physics.
- Curriculum and courses: designing relevant and flexible curriculum to be suitable to a wide range of students and relevant to workplace contexts.
- Teaching and learning: moving towards student-centred approaches to make learning occur in students and taking advantage of the development of ICTs to make teaching more interesting, effective and related to real life contexts.

2.4. New approaches in teaching and learning of physics

Over the last decade, a substantial body of research has been developing to investigate various teaching approaches in order to solve the problems associated with traditional instruction and to foster the quality of student physics learning. Most research in science education has verified the constructivist view of learning and shown that learning occurs when students construct knowledge for themselves (Dykstra et al., 1999). As a result, teaching physics effectively involves encouraging the kind of learning that leads to conceptual change and facilitating students developing physics conceptions (Chu, Treagust, and Chandrasegaran, 2008; Mulhall & Gunstone, 2007).

This section will discuss the philosophy underlying contemporary approaches in teaching and learning – constructivism, and new interactive engaging learning approaches in teaching and learning of undergraduate physics.

2.4.1. Teaching constructively

The effectiveness of constructivist learning approaches has been thoroughly studied by a large number of researchers for several decades. The constructivist learning theory considers that students are active in their process of acquiring new knowledge. Furthermore, according to Ng and Nguyen (2006), students develop and improve their understanding of knowledge through a process of developing, testing and reshaping their understandings based on their existing experiences. It considers learning as a dynamic process of interactions between learners and the surrounding environment, influenced by students’ prior understandings. Ng and Nguyen (2006, p. 41) also indicate that “this prior knowledge that learners possess influences their learning process, they are not passive recipients of knowledge and conceptual changes will result from their prior understandings being challenged and revised (de-constructing and re-constructing where necessary).”
From the view of constructivism, the teacher in a constructivist classroom plays a role as a facilitator to ensure that students are active engaged in their learning. In this classroom, students have opportunities to actively participate in exploration, discussion, and working in groups. The characteristics of this classroom can be identified through activities such as group discussions, ‘hands-on’ and interactive engaging learning approaches, the integration of real life examples, and project-based learning. As a result, in constructivist teaching approaches, teachers should pay attention to develop students’ higher order thinking, skills, independent learning ability, and flexibility in adjusting to changing conditions (Altbach et al., 2009; Hativa, 2000).

Physics is considered a practical science. Therefore, using constructivist learning approaches in undergraduate physics teaching practices is necessary for students to experience a wide range of practical activities. Physics lecturers should integrate practical work, real life examples, demonstrations, and applications into their lectures. In order to integrate interactive engaging approaches into teaching, the availability of adequate and advanced ICT infrastructure, of laboratory facilities and equipment, and of teaching and learning resources is one of the vital factors. The pedagogical knowledge of teaching staff and the support from universities and physics departments are also important in successfully implementing IE student-centred learning approaches in undergraduate physics.

2.4.2. Using interactive engaging learning approaches in physics teaching

Today, the move towards student-centred learning approaches in classrooms is universally advocated. The most important feature of a student-centred learning approach is the learning environment where students are motivated to construct knowledge for themselves, rather than the knowledge being transmitted by their instructors as in traditional learning approaches. This kind of teaching has various labels such as interactive engagement, active learning, and guided inquiry. According to Hake (1998):

Interactive engagement (IE) methods are those designed at least to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors (p. 65).
The philosophy underlying IE teaching approaches is the constructivist theory of learning. Although there are many approaches to IE, they all contain some common characteristics. For example, IE teaching and learning approaches focus on students’ engagement of their mind in cognitive processes such as analysis, synthesis, and evaluation instead of passive listening to lectures and following instructions and set-up procedures in solving homework problems and doing practical work. IE teaching approaches also emphasise the students’ exploration of their own attitudes and values. For instance, students may be asked to predict, to solve problems, to develop theoretical models and to discuss possible models that explain physical phenomena in various class settings (Bonwell & Eison, 1991).

To verify the advantages of IE approaches in teaching and learning of physics compared to traditional teaching methods, Hake (1998, p. 71) conducted a survey of 62 introductory physics courses enrolling a total number of 6,542 students using the Halloun-Hestenes Mechanics Diagnostic test. The survey indicates that “IE methods enhance students’ problem-solving ability” and “the use of IE strategies can increase mechanics course effectiveness well beyond that obtained with traditional methods”. Savinainen (2001) also made a similar study on the teaching and learning of Newtonian mechanics to students aged from 16 to 19 in a Finnish High School using the Force Concept Inventory (FCI). The results of this study strongly indicate that Interactive Conceptual Instruction is very useful in enhancing conceptual understanding in mechanics.

Examples of IE methods employed by physics teaching staff are: Microcomputer-based Labs, Modelling, Active Learning Problem Sets, Overview Case Studies, Socratic Dialogue Inducing Labs, Problem-Based Learning, and Peer Instruction. These physics teaching approaches have been extensively studied and proven that students have a better understanding of physics concepts and problem solving skills than in traditional teacher-centred learning approaches (Chang and Bell, 2002; DeHann, 2005; Finkelstein & Pollock, 2005; Ogilvie, 2009; Pundak & Rozner, 2008; Smith & Wittmann, 2007). Many physics lecturers in Australian universities have been using IE teaching approaches in their physics instruction. The following IE
teaching methods are some examples that have been applied in physics teaching in Australian universities.

Peer instruction (Mazur, 1997)

Peer Instruction (PI) has been applied for many years in teaching and learning of undergraduate physics at Monash University and the University of Melbourne with the aim of making students more interactive and engaged in their learning process. This teaching technique was first introduced by Harvard physics Professor Eric Mazur and others in the early 1990s and has become widely used in undergraduate science and mathematics teaching. PI teaching method is a teaching technique that encourages students’ interaction in lectures and to focus students’ attention on underlying concepts. Students are given a short conceptual multiple-choice format 'quiz question' and some time to think about the answers. The interesting feature of this technique is all students in the class are involved in voting on the answer to the question using electronic response system ('clickers'), flash cards, or simply by show of hands. Depending on the number of correct answers the lecturer decides to continue the lecture, stop to explain topic again or let students discuss with their peers in few minutes then do voting again.

A report from Crouch and Mazur (2001, p. 19) on data from ten years of teaching using PI in the calculus and algebra-based introductory physics courses for non-majors show that “students’ scores on the Force Concept Inventory and the Mechanics Baseline Test improved dramatically, and their performance on traditional quantitative problems improved as well. There was also an increase in student engagement in discussion sections and increase in student understanding. These results were not dependent on a particular instructor and were seen in both the algebra-based and calculus-based courses”.

Exploratorial

The University of New South Wales’s School of Physics exploits a teaching technique named Exploratorial, which is a 2-hour session held every second week in the laboratory timeslot. Exploratorial combines practical activities with tutorial type problem solving. These sessions aim to connect knowledge learnt in lectures, tutorials and laboratories together (School of Physics, University of NSW, Australia, 2004). The purpose of Exploratorial is to integrate the experimental, theoretical and numerical
aspects together with supports of a range of media rather than teaching separately in different contexts in conventional teaching. Particularly, according to the School of Physics (2004) the Exploratorial is designed to:

- Relate theories students learn in lectures to the real world;
- Help students get a deeper understanding of physical concepts;
- Help students apply physical concepts learnt in lectures to solve problems;
- Help students remember concepts and problem solving skills by using pre-work and post-work to reinforce learning;
- Give students practice at solving the sorts of problems that they will find in exams.

Before coming to class, students are required to do pre-work, which include reading materials, doing web quizzes and solving tutorial problems that are available on the school’s website. The next step in the process of learning is class-work, which students listen to the introduction given by tutors and then work in groups of four students to complete practical activities and solve problems by writing all answers on provided worksheets. The final step is called post-work, in which students solve problems posted on the school’s website using concepts and skills learnt in class-work sessions.

Using the Exploratorial in physics teaching is likely to help students understand physics concepts deeper and invoke long-term memory in students because students have opportunities to together link and use physics knowledge that they learn in different contexts together. The Exploratorial also makes learning become more meaningful because it gives students opportunities to see the connection between theoretical knowledge of physics and its applications. Moreover, this teaching technique encourages students to learn physics independently at home and cooperatively in classrooms since students are involved in working in groups.

The Workshop Tutorial Project

The Workshop Tutorial Project (WTP) has been applied in undergraduate teaching of physics by the University of Sydney, University of New South Wales, Australian Catholic University, University of Western Sydney and the University of Technology Sydney. The WTP aims at developing cooperative learning across a large
range of topics for first year physics students. In these workshops, students have opportunities to “discuss problems in physics and explore different avenues of solution without feeling that there is one correct solution that must be marked. This produces a stress free environment with student-driven rather than assessment-driven learning. The control and responsibility for learning rests with the students. The solutions are provided to students as they leave the class giving them immediate feedback on their ideas” (UniServe Science, 2002).

2.4.3. Summary

According to constructivist learning theory, effective teaching encourages the active participation of students in their learning process by giving them opportunities to actively participate in a range of student-centred learning activities. Understanding the importance of teaching constructively in improving the quality of student learning, most physics departments encourage their teaching staff to develop IE student-centred learning approaches in their undergraduate teaching practices.

In Australia, there has been considerable effort to foster the application of physics education research on IE teaching and learning strategies and the use of ICTs in undergraduate physics teaching. Particularly, many Australian physics departments have applied IE student-centred teaching methods into their physics instructions such as Peer Instruction at Monash University, Exploratorial at the University of New South Wales, and the Workshop Tutorial Project at the University of Sydney. The most common feature of these teaching approaches is to engage students in learning activities where they have opportunities to discuss and exchange their understanding of physics knowledge with peers.

2.5. Undergraduate physics teaching and learning practices in Vietnam

In recent years, through awareness of the vital role of education, especially higher education as a contributor to the development of economic, technical, and social progress, the Vietnamese government has fully supported moves to improve the quality of its higher education. In 2005, the Vietnamese Prime Minister signed the 5th Resolution on Fundamental and Comprehensive Reform of Higher Education over a period from 2006 to 2020 with the aim of improving the quality and quantity of higher
education in order to meet demands of industrialisation and modernisation in Vietnam. The government also set the goal that in 2020 Vietnamese higher education must catch up with educational standards in ASEAN countries such as Singapore, Thailand, and Malaysia.

For many decades, science subjects and courses in most Vietnamese institutions, especially physical sciences have been taught and learnt with inadequate teaching and learning facilities and resources, a low level of pedagogical skills, and a traditional curriculum and syllabus. Consequently, teaching physical sciences usually focuses on theoretical knowledge and lacks practical components and applications. Nonetheless, in recent years, there has been a gradual change in teaching and learning practices in Vietnam towards more student-centred approaches, especially at higher education level. The MOET has encouraged school teachers and university teaching staff to implement student-centred approaches in their teaching and training. Although there has been an improvement in student learning outcomes compared to the past, there is still resistance to the change and thus the overall result gained in the process is still insignificant.

This section will review the education system in Vietnam, its history of education and current undergraduate physics teaching and learning practices to provide an insight into how physics is delivered in Vietnam.

2.5.1. Overview of the Vietnamese education and physics education

Vietnam is a developing country in South East Asia with a GDP per capita is about 1,052 USD (about 2.5% GDP per capita of Australia) ranked 137th in the world (IMF, 2009). Vietnam has 54 ethnic groups of which the majority is King (86.2%) living in 64 cities and provinces. The Vietnamese national education system is unified and centralised under the Ministry of Education and Training. At general educational levels, curricula and textbooks are designed, provided and monitored by the MOET and applied throughout the country. At the higher education level, curricula, courses and subject syllabi provided by higher institutions must follow guidelines from the MOET.

In general, Vietnamese education is divided into five subsystems, which are:
- Pre-school education has two levels: kindergartens and family day care for children aged 3-36 months, and nursery schools for children aged 3-6 years.
- Primary school: compulsory for all students aged 6 to 10, comprised of six grades (1 to 5).
- Secondary education: divided into Lower secondary (grades 6 to 9) and Upper Secondary education (grades 10 to 12).
- Tertiary education: a short-cycle program of three to three-and-a-half years' duration, offered mainly by colleges; Long-cycle bachelor degree programs offered at universities; and postgraduate programs at master and doctoral levels.
- Non-formal education: covers literacy and post-literacy programs for adults under 40 as well as life skills and training programs in Community Learning Centres and Community continuing Education Centres at the grassroots level. (Henaff, Lange and Tran, 2007, p. 4)

At general education levels, students begin studying physics as a separate subject at grade 6 until grade 12. It is compulsory for all students to study physics at these levels. At upper secondary level, the physics curriculum is designed for two streams of students. Students can choose to study physics designed for arts, social science and humanities with physics curricula being less mathematical emphasising conceptual and mainly emphasising theories. The other stream is the physics curriculum with a high level of physics and mathematics designed for students who will study natural sciences in the future.

For natural science oriented students, during their time studying at general education levels, they have to complete almost all physics topics ranging from classical physics to modern physics. To illustrate, the physics content in the year twelve compulsory textbook that is designed and published by the MOET includes: Mechanical Oscillations, Mechanical Waves and Sound, Electric Oscillations and Alternating Current, Electromagnetic Oscillation and Electromagnetic Waves, Reflection and Refraction of Light, Eyes and Optical Instruments, Wave Properties of Light, Particle of Light, Introduction to Nuclear Physics, and Theory of Relativity (Nguyen et al., 2009).

In order to gain a general education certificate, all year 12 students have to sit for a national compulsory examination, which includes six subjects with physics being usually chosen as one of the subjects. After gaining the general education certificate, students are required to pass a competitive national university entrance examination to study physics courses in higher education institutions. This examination includes three compulsory subjects which are mathematics, physics, and chemistry. These three subjects are considered to be so important that many students are guided by their parents to focus on them during their early ages.
All physics students in the first one and a half years at a higher institution study the same subjects. This stage is named the general stage of tertiary education. In this stage, besides introductory physics components, physics students have to study many other non-physics subjects such as Marxist-Leninist philosophy, history of the Vietnamese Communist Party, Ho Chi Minh idealism, country defense education, algebra and calculus, and English. After finishing the general stage, the students can then enter to study their professional programs which include core and elective subjects for two and a half years.

In Vietnam, the MOET also takes a main role responsible for its higher education standards. Although in recent years, there has been a change towards encouraging more institutional initiative, Vietnamese higher education institutions are still very much under the guidance and supervision of the MOET in many aspects. The MOET also takes a major responsibility to monitor standards in the accreditation of quality assurance for universities and colleges’ courses and their teaching and learning practices. Therefore, physics curricula, courses and undergraduate physics teaching and learning practices are also under the guidance and supervision of the MOET.

2.5.2. History of education in Vietnam

To understand teaching and learning practices in Vietnam, it is necessary to know some of its cultural aspects of teaching and learning because according to Masson (2007, p. 165), “cultural factors are indeed associated and influence many aspects of education”.

Confucian Model of Education System in Vietnam (1076 – 1885)

During 4,000 years of Vietnamese history, over one thousand years of its history was under the rule of many feudal dynasties from China. The Chinese dynasties always tried to assimilate Vietnamese culture into Chinese culture under their rules. As a result, Vietnamese culture was strongly influenced by hegemonic Chinese dynasties. Particularly, Confucianism was introduced to Vietnam in the first century by the Han dynasty and Confucian philosophy had been accepted as a national philosophy in politics, education and social life in Vietnam for centuries and it still has strong influences in every aspects of Vietnamese society today (Tran, 1995).
Under the influence of Confucianism, Vietnamese people inherit some unique characteristics such as the spirit of self-cultivation, fondness of learning, the attitude of not challenging, and a self-disciplined life style (Tran, 1995). With the attitude of respecting elders and teachers, for a long period of time, teachers have always been held in high esteem and students have not normally challenged what happens in their classrooms. This non challenging characteristic contributes to the teacher-centred teaching style and rote learning methods that are popular in Vietnamese education and it is difficult to change.

Vietnamese education under many Vietnamese feudal dynasties started from 1076 to 1885 followed mainly a Confucian education system because most Vietnamese feudal dynasties considered Confucianism as their main ideology. This system of education used Confucian ideals as the content of teaching, in which students were taught to love and obey their parents and older people and to be loyal to feudal dynasties. This education system also highly valued examinations and considered examination as an extremely important means to choose knowledgeable and loyal people. Therefore, people considered learning as a way to be promoted so that they worked to pass examinations using any means they could have (Tran, 2009). This examination-based learning had lasted for hundreds of years in Vietnamese society and it is still affecting current generations of Vietnamese people.

French Model of Education (1885 – 1945)

In 1858, France invaded South Vietnam and then they ruled all Vietnam. The French used many methods to replace the Confucian education system by a French-Vietnamese education system. The French-Vietnamese education system was fully applied in all Vietnam in 1917 for the French living in Vietnam and a small number of the Vietnamese elite. This system had three levels of education: primary school level; secondary school level; and tertiary level. In this system, curricula and textbooks were adopted from the French education system and students were taught in French by French teachers. This French-Vietnamese education system brought Vietnamese education to a new level and helped to train many Vietnamese intellectuals (Tran, 2009).

In 1954, North Vietnam defeated France and became an independent state. The education system in North Vietnam was adopted from the Soviet education system. In addition, 30th April 1975 marked the biggest change in the history of Vietnam. After over one hundred years fighting with the invaders from France and the United States of America, Vietnam regained its independence as a whole country and rebuilt its socialism from the ravages of wars. For nearly one decade (from 1975 to 1986) after the war, Vietnam struggled to lift the country out of poverty. At this time, the prosperity of Vietnam depended on the aid of the Soviet Union and other communist countries such as China, Cuba, and some Eastern European countries. Education was not an exception. The lack of infrastructure, classrooms, schools, teaching and learning materials, and experimental equipment was one of the reasons contributing to a teaching and learning style that was mainly theoretically-based with little or no laboratory work.

Innovative Model of Education (1986 – current)

In 1986, the 6th National Party Congress launched an innovation program (Đổi Mới) with the aim of reforming all aspects of social life and opening the door (Mở Cửa) for foreign countries to invest into Vietnam. Vietnamese economics and social life have positively changed and improved. Especially after the fall of the Soviet Union in 1991 and the abrogation of the embargo from the U.S. in 1994, Vietnam has gradually integrated into the global economy and international agendas and issues. Education has also been highly valued as “a determining factor for the success or failure of a nation in international competitions and for the success of each individual in his life” (MOET, 2001, p. 3). The Resolutions of the 7th and 8th Party's Congresses and 1992 Constitution confirm that education is the first priority of national policies.

As a result, for the last two decades, Vietnamese education, especially the higher education sector, has experienced a profound change. The change in higher education can be illustrated by the data concerning the expansion of existing institutions as well as by the establishment of many new universities and colleges in all parts of Vietnam. Particularly, in 1987, Vietnam had 101 universities and colleges with 133,000 students and this number expanded to 422 universities and colleges and over 1.7 million students
in 2009 (Ho & Berg, 2010). The number of higher education students increased from 133,000 in 1987 to over 1.7 million in 2009, an increase of 92% with the 2009 enrolments representing 13 times those experienced in 1987. The number of lecturers has also increased by over 3 times from 20,000 in 1987 to over 61,000 in 2009 (MOET, 2009).

In term of educational policies and future directions, Vietnam has gradually escaped from the influence of the old Soviet Union and then Russia to fully integrate into international contexts. In its *Solutions for Education Development* published by MOET (2006c), its education strategies are: to develop cooperating projects in the field of science research and education research in higher education institutions, research institutes, centres that are specialised in education; to exchange information and to organise workshops and international conferences; and to participate in the activities of United Nations organisations, the organisations of French speaking countries, the organisations of the Asia Pacific region, Asia-Europe organisations and others.

In fact, from the beginning of the 1990s Vietnam has been an active partner of Education For All (EFA) and in 2000, Vietnam participated in the World Education Forum conference in Dakar, Senegal and committed itself to draw up a credible EFA plan (Vietnamese Government, 2003). In recent years, Vietnam has actively cooperated with higher educational organisations in the Organisation for Economic Co-operation and Development (OECD) countries. It also sends over one thousand students to these countries annually to study at post graduate level (MOET, 2009).

### 2.5.3. Current status of undergraduate physics teaching practices in Vietnam

According to the 5th Resolution of the Vietnamese Government on the Fundamental and Comprehensive Reform of Higher Education over the period from 2006 to 2020 (Nghị quyết về đổi mới cơ bản và toàn diện giáo dục Đại học Việt Nam giai đoạn 2006 – 2020), after twenty years of education innovation and five years of performing Strategies for Educational Development from 2005 to 2010 (Chiến lược phát triển giáo dục năm 2006 – 2010), the Vietnamese higher education has begun changing positively and has achieved important results such as an increase in enrolment, the
diversification of courses and curricula, and innovation of curricula and training processes (Prime Minister Phan Văn Khải, 2005).

In most recent years, there has been a gradual change in teaching and learning practices in Vietnam, especially in the higher education sector, which has resulted from the requirement of industrialisation and modernisation, the development of science and technology, globalisation and internationalisation, and training that follows a credit point system. Understanding the importance of student active learning, the MOET has encouraged school and university teachers to implement student-centred approaches in their daily teaching and training.

Nevertheless, according to the MOET (2006b), the Vietnamese higher education still has many problems that need to be solved in order to improve its quality of student learning. These problems may be identified as: the low quality of teaching and learning practices; the imbalance in structure of courses and curricula; the lack of effectiveness; the lack of real life applications; the lack of connection with entrepreneurs.

In the area of undergraduate physics education, according to the Report of the site visit team of National Academies in the U.S. (Director et al., 2006), undergraduate physics in Vietnam has many serious problems. These problems are:

- the experimental or practical laboratories for undergraduates, in general, are quite out of date, simplistic, or lacking in equipment;
- the physics curricula have a large number of requirements and very little elective choice;
- students get little feedback on their performance during the academic year and many do not have time to do their homework assignments; and
- the teaching staff are overworked in order to earn a living wage and thus do not have much time to support students and to respond to their performance (p. 27).

In fact, over the last ten years, there have been changes and restructuring in undergraduate physics teaching practices in Vietnam. According to Le (2001, p. 15), “most changes have been focused on course structures and content but not on the operation of courses and their contribution to higher education”. In addition, with the lack of teaching facilities and resources and the habit of using traditional teaching approaches, many undergraduate physics lecturers are still relying on their lectures as the sole way to transmit course information to students. Le (2001, p. 16) also stated that physics teaching in Vietnam “has mainly aimed to supply factual subject-based
knowledge but done little or nothing to broaden physics knowledge or enhance the intellectual skills of students”.

Therefore, in order to fulfil the expectations from the Government that “education and science-technology should have a more decisive role in contributing to the development of the nation and education should make one step in advance to improve mass knowledge, to train manpower and to nurture the talents in order to carry out successfully the socio-economic strategic goals” (MOET, 2006b), higher education in general and physics education in particular should take actions and make changes to improve the quality of student learning.

2.5.4. Summary

Vietnamese education has experienced many changes and has been under the influence of many countries throughout Vietnamese history. In recent years, Vietnamese education in general and the higher education sector in particular has gradually changed its educational practices from the influence of the Soviet Union towards collaboration with international education organisations and higher institutions in developed Western countries. There have been changes and restructurings of physics courses and curricula at all levels of education in Vietnam regarding the move towards a credit point system adopted from the U.S. However, current undergraduate physics teaching and learning practices in most Vietnamese universities have many problems such as the lack of teaching and learning facilities and resources, a large number of subjects and requirements, and the dominance of traditional teacher-centred teaching and learning approaches in the classroom.

2.6. Cultural, political and economic differences

Vietnam is entirely different from Australia regarding its culture and political system. The cultural and political differences between Vietnam and Australia definitely affect the practice of education in each country. The different states of the economy between the two countries also affect the practice of education. This section will review cultural, political and economic differences between the two countries, which might throw light on the pathway to improve education practices in Vietnam.
2.6.1. Cultural, political and economic differences between Vietnam and Australia

Vietnam

Vietnam is a one-party communist country in south-east Asia with a total population of about 89.7 million in 2012 (BBC, 2013a). Vietnam is a lower middle income country with GNI per capita was about US $1,130 by the end of 2010 (the World Bank, 2013). As described in the previous section, Vietnam was under the influence of many countries, in which many Chinese feudal dynasties invaded Vietnam for a total of more than a thousand years. As a result, Vietnamese culture, and hence its education is strongly influenced by Confucianism, and hence its education. In this culture, teachers have always been held in high esteem and students have not normally challenged what happened in their classrooms. The Vietnamese education system is centralised under the authority of the MOET. Although Vietnamese universities today have their freedom in designing courses and curricula, the MOET still has a great influence on their teaching and learning practices. For example, the curricula and courses designed by the universities have to follow guidelines from standard curricula and courses of the same degrees released by the MOET.

Australia

Australia is a multicultural country and a democratic society with a population of about 22.9 million (BBC, 2013b). Australia is a developed country with very strong and advanced economy in the Organisation for Economic Co-operation and Development. Its GNI per capita was about US $49,790 and the world’s 13th-largest economy in 2011 (DFAT, 2013). The Australian education system is one of the highest quality, effective and efficient system in the areas of research, teaching and learning, and training academics and the labour force. According to Department of Foreign Affair and Trade (DFAT) (2013), seven Australian universities were in the list of top 200 higher education institutions in the world in the Times Higher Education World University Rankings 2011.
2.6.2. Constraints affect the pathway to improve Vietnamese education practices

As can be seen in the previous section, Vietnam and Australia are entirely different in culture, political system and the state of economy. Australia is a democratic society which encourages the active participation of its citizens in all aspects of its society. According to DFAT (2008), “the Australian government encourages people to learn about and participate in Australia’s democratic institutions. Key democratic principles and practices include responsible government; the separation of legislative, executive and judicial powers; the observance of constitutional safeguards; the rule of law; a transparent criminal justice system; equitably resourced and respected opposition parties; and a free media. Australia’s strong democratic institutions are complemented by a number of specific legal protections for human rights”. On the other hand, in Vietnamese culture, students, especially students in lower levels of education, are not encouraged to challenge their teachers, and hence there is a dominance of teacher-centred teaching approaches in the classroom. This different characteristic of teaching and learning in the classroom is a constraint for Vietnamese universities to implement successful features in undergraduate physics teaching practices from Australian universities.

The difference in the state of economy is another constraint for Vietnamese universities in improving the quality of physics education from Australian universities’ experience. Particularly, with more funding and the income from international students, Australian universities are likely to invest more to improve their infrastructure, facilities, resources, and teaching and research staff. Especially, ICT infrastructure and its services are crucial in today’s teaching and learning practices. The lack of ICT infrastructure and digital resources as well as the inadequacy of teaching and learning facilities and resources make it difficult for Vietnamese universities to catch up with the quality of teaching and learning in Australia and in other developed countries in general.

However, although there are differences in terms of economy, culture, and political system, with the strong commitment of the Vietnamese Government to seek direction for advancement from developed countries, the Vietnamese higher education sector has the opportunity to learn from the experiences of education in developed countries to improve its quality of teaching and learning. At the same time, higher
education institutions in Vietnam have also been prepared to receive changes in their educational practices, in which the change to a credit point system is a good example. Moreover, according to the MOET (2009), over 30 universities in Vietnam have programs for international cooperation with good performance and have reached agreements with higher education institutions around the world to provide combined programs and courses for Vietnamese students.

In addition, there have been several international universities successfully operating in Vietnam. RMIT International University Vietnam with two campuses in Hanoi and Ho Chi Minh City is a good example. RMIT Vietnam has grown rapidly since it opened its doors in 2001, today there are more than 3,000 students enrolling into degree programs and some 2,000 into Academic English classes (RMIT, 2013). The success of this high-profile institution in Vietnam further suggests that Vietnam is ready to make changes and to integrate experiences from higher education institutions in developed countries into its own teaching and learning practices.

2.7. Chapter summary

This chapter has outlined the issues in teaching and learning in higher education in general and teaching and learning undergraduate physics in particular. During the last several years, higher education sectors have changed profoundly as a result of the growth and increasing diversity of the student population, the transforming effect of information and communication technologies, the increasing global competition and internationalisation, and the attention to quality and accountability.

Apart from the changes driven by the general trends of the development in higher education, undergraduate physics with its specialisation as a fundamental science has its own issues such as the decline of the number of physics students, the changes in the nature of students, the problems with traditional teaching and learning approaches, the change in physics content knowledge, and the influence of ICTs. Among these issues, the problems created by traditional teaching approaches have prompted education researchers to put much effort on reforming undergraduate physics education. Much research on the field of physics education has revealed that traditional teaching approaches which focus on the physics content and not on students, are ineffective in
helping students to develop a more scientific view and conceptual understandings of physics (Biggs, 2003; Mulhall & Gunstone, 2007; Pundak & Rozner, 2008; Redish et al., 1998; Welzel, 1997).

Constructivist theory provides a fruitful perspective to explain the ways knowledge is being constructed. Research on physics education also reveals that IE teaching methods and student-centred approaches, which focus on requiring students to engage their mind in cognitive processes beyond passive listening in class or laboratory settings, or beyond passive reading while engaging with a text or using computer-based materials, leads to conceptual change and facilitates students developing physics conceptions for themselves (Chu et al., 2008; Mulhall & Gunstone, 2007).

In Australia and Vietnam, there has been a move towards more student-centred physics teaching and learning approaches. In Australia for example, some physics departments have introduced and applied IE teaching methods into their physics instructions, typically PI at Monash University, Exploratorials at UNSW, and Workshop Tutorial Project at the University of Sydney. However, because of the differences in culture, in leadership, in the norms of teaching and learning practices, in the nature of students, and in teaching and learning resources, there are dissimilarities in current teaching and learning of undergraduate physics between Australian and Vietnamese universities. These dissimilarities and differences are likely to affect the pathway to improve the quality of undergraduate physics teaching and learning practices in Vietnamese universities.

Vietnam is looking to the experience of developed western countries to provide a model for ways forward for its education system and for physics education. However, substantial differences in culture and context limit the extent to which ideas and approaches can be transplanted across national boundaries. This study will undertake an in depth comparison of undergraduate physics education in Vietnam and Australia to identify similarities and differences and the factors that contribute to these. Thus, it will assess the possibilities and constraints for improving practice in both countries, but particularly focus on lessons for improving Vietnamese physics education based on the Australian experience.
Chapter 3. Research Methodology

3.1. Introduction

According to Wiersma and Jurs (2005, p. 2), “education is a complex process. Students and teachers in schools find themselves in complex and fluctuating networks of social interaction”. As a result, doing research in education is complex and demanding. Realising the complicated process of educational research, this chapter outlines the research methodology employed in this study.

Research is a systematic process involving a series of specific activities. These activities include five steps: identifying the problem; reviewing information; collecting data; analysing data; and drawing conclusions. These steps are illustrated in Figure 3.1 (Wiersma and Jurs, 2005, p. 22).

![Sequential patterns of activities in conducting a research study and the relationship of such activities to existing knowledge](image)

**Figure 3.1.** Sequential patterns of activities in conducting a research study and the relationship of such activities to existing knowledge
The research problem in my study is encapsulated in the overarching question of the investigation. The overarching question guiding this study is “what are potential changes in teaching and learning of undergraduate physics in Vietnam, which can be learnt from the Australian universities’ experience?” and it is embraced in the research questions.

Following the systematic process of educational research, the existing body of knowledge relative to this study has been reviewed in the previous chapter. The next steps of the research sequence are data collection and data analysis procedures. The data collection and data analysis procedures are discussed in this chapter. While undergraduate physics teaching and learning practices vary from university to university, because of practical constraints this study is limited to an in-depth study of physics departments in three universities in Australia and three universities in Vietnam.

3.2. The research design

The research design is a plan or strategy for conducting the research. According to a definition from Bieger and Gerlach (1996, p. 49), “the fundamental goal of a research design is to develop a set of methods and procedures that will answer the research question or test the hypothesis with a high degree of confidence”. Because this study is performed in two countries and it collects data from people and through processes of observation and documentation analysis, it employs mixed research methods which include both quantitative and qualitative techniques. The mixed research methods are summarised in Figure 3.2. The research instrumentation of this study includes: questionnaires, interviews, observations, and the analysis of documentation.

According to Wiersma and Jurs (2005), using mixed methods in research has a number of advantages. These advantages are:

- avoiding possible uni-method bias: because each method has its strengths and weaknesses, using more than one method in the same research study allows the researcher to capitalise on the strengths of each method;
- appealing to different audiences: some people will be persuaded only by the results of “rigorous” experimental research, while others are more convinced by the rich information provided by ethnographic research. Using mixed methods will increase the likelihood that a wider audience will find the conclusions convincing and use the findings;
- providing different sightlines enabling researcher to look at something from a variety of perspectives, for a more comprehensive understanding. Educational outcomes are complex and often influenced by a variety of factors. A limited research design may only provide part of the picture. Mixed methods can give a more complete understanding of the phenomenon being investigated;
- addressing multiple questions: this is probably the greatest advantage of mixed methods because it allows researchers to explore diverse questions, which is so often the situation in education research (p. 276).

Figure 3.2: Summary of Research Design
3.2.1. The approach of this study

As mentioned earlier, both quantitative and qualitative approaches are employed in this study. This study also employs triangulation technique in its data collection to improve the internal validity of the study. As defined by Burns (2000, p. 419), “triangulation is the use of two or more methods of data collection in the study of some aspect of human behaviour”. The triangulation in this study is employed both for subjects and the instrumentation of the study as shown in figure 3.3.

![Figure 3.3: Triangulation technique used in this study](image)

Particularly, the instrumentation used to collect data includes four types: questionnaires, interviews, field observations and documentation. The subjects of this study are physics teaching staff, undergraduate physics students, physics education innovators and heads of physics departments. By using triangulation the bias can be reduced compared to the use of only questionnaires, interviews, field observations, or document analysis alone. The data collected from three different institutions and categories of participants is also more reliable and potentially reduces the bias.

In this study, the questionnaires are associated with the quantitative and qualitative research and the interviews, observations and document analysis belong to qualitative research methods. These two research methods are employed because besides gathering numerical data, the study determines participants’ perspectives and opinions on undergraduate physics teaching and learning practices, and their suggestions for changes and future directions of tertiary physics. Combining qualitative and quantitative
research methods in this study also improves the validity and coherence of the research findings because strengths of each method complement weaknesses of the other.

3.2.2. Quantitative and qualitative research methods

Two distinct scientific approaches to research methodology in education are quantitative and qualitative, in which each approach has its own terminology, methods, and techniques. These two research methodologies arise because of the different philosophical assumptions that researchers approach problems and collect and analyse data (Ary, Jacobs and Razavieh, 2002).

According to Ary et al. (2002), quantitative research had its origins in positivism. In this kind of research, quantitative researchers believe that general principles or laws governing the physical world can be generally adopted to design experiments or survey to study the social world. Quantitative researchers thus consider measurement and collecting data with objective techniques as the optimal way to answer research questions and to give explanation and predict human behaviour. In other words, quantitative research is the scientific method of research in which the data can be analysed in terms of numbers (Best and Kahn, 1998).

The other approach is qualitative research. Ary et al. (2002, p. 22) states that “qualitative research is rooted in phenomenology, which sees social reality as unique. The phenomenological approach sees the individual and his or her world as so interconnected that essentially the one has no existence without the other”. Therefore, to understand human behaviour, qualitative researchers must not only look at what people do but also at their contexts, their beliefs, values and responses. As a result, qualitative research uses different forms of data compared with quantitative methods, and the result of this kind of research is usually a narrative report without the use of numerical data (Best and Kahn, 1998; Ary et al., 2002). Table 3.1 summarises the major characteristics of the quantitative and qualitative research approaches:
Table 3.1: Comparison of Quantitative and Qualitative Research (Ary et al, 2002)

<table>
<thead>
<tr>
<th>QUANTITATIVE</th>
<th>QUALITATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose: To study relationships, cause and effect</td>
<td>To understand social phenomena</td>
</tr>
<tr>
<td>Design: Develop prior to study</td>
<td>Evolves during study</td>
</tr>
<tr>
<td>Approach: Deductive; tests theory</td>
<td>Inductive; generates theory</td>
</tr>
<tr>
<td>Tools: Uses standardised instruments</td>
<td>Uses face-to-face interaction</td>
</tr>
<tr>
<td>Sample: Uses large samples</td>
<td>Uses small samples</td>
</tr>
<tr>
<td>Analysis: Statistical analysis of numeric data</td>
<td>Narrative description and interpretation</td>
</tr>
</tbody>
</table>

Although quantitative and qualitative approaches have distinct differences in the type of data collected, the forms of analysis and the distance between the researcher and the problem investigated, neither approach is inherently superior to the other. In education research, both methodologies are essential and valuable. Since both of these research methodologies have advantages and disadvantages the choice of one over the other, or using simultaneously both methodologies, is dependent on particular research problems (Ary et al., 2002). Walker (1985, cited in Ary et al., 2002, p. 23) stated that “certain questions can not be answered by quantitative methods, while others can not be answered by qualitative ones”.

3.2.3. Subjects of this study

This research has been conducted in three physics departments in three Australian universities and in three physics departments in three Vietnamese universities. Among the three universities in Australia, two universities have high rankings in Australia with excellent infrastructures, facilities and resources. Their quality of undergraduate physics teaching and learning practices and the quality of incoming undergraduate physics students are very good. The third university is considered as an average ranked university in Australia with good infrastructure but low quality of incoming physics students compared to other two universities. Similarly, two Vietnamese universities in the three studied universities in Vietnam are largely considered to be high-ranking in Vietnam with good infrastructure. The other Vietnamese university is of average ranking in Vietnam and it also trains physics students to become physics teachers in secondary school levels.
In all these physics departments, observations of undergraduate physics teaching and learning infrastructure, lectures, tutorials and laboratory sessions were made. Documentation of physics curricula, subject syllabi, and laboratory manuals were collected and analysed. The questionnaire for students was given directly to undergraduate physics students in these physics departments in both countries. Some individual students and focus groups of students were interviewed. A similar process was followed for physics teaching staff in these departments. The staff were interviewed individually in their offices. This study included interviews with several heads of physics departments and with several physics education innovators who had undertaken a substantial amount of research on physics education.

In Australia, there were nine lecturers, two heads of physics departments, four innovators and eighty nine students who participated in this study. In Vietnam, the number of participants was ten lecturers, 147 students and several physics education innovators.

The opinions and perspectives on undergraduate physics teaching and learning practices of the Vietnamese innovators were collected during their presentations at The 7th National Physics Education Conference held in Hanoi on 8th – 12th October 2010. These innovators were physics education researchers and they were considered to be equivalent to the physics innovators interviewed in Australia. The data for this study were collected from conference proceedings and the presentations at the conference. The data collected from this conference were very useful because most Vietnamese undergraduate physics teaching staff, physics education researchers and innovators, and policy makers of physics education attended and presented conference papers and communicated their opinions on current school and tertiary physics teaching and learning practices.

3.3. **Data collection and instrumentation**

According to Wiersma and Jurs (2005, p. 205), “methods of data collection are interactive or non-interactive depending on whether or not the researcher interacts with the subjects being studied. Observation, interview, and document collection and review
are commonly used methods, and taking specimen records and oral histories are possible methods of data collection in qualitative research”.

In this study, the data were collected from four instruments: surveys to seek information from undergraduate physics teaching staff and students; in-depth interviews with physics teaching staff, students, directors of physics departments and physics education innovators; observations of teaching and learning facilities and resources, lectures, tutorials, and laboratory sessions; and document collection and review of departmental policies and development strategies, physics programs and courses, and curricula and subject syllabi.

3.3.1. The questionnaires

Among surveys, according to Nikakis (2002, p. 95), “the method of data collection that is one of the distinguishing characteristics, and certainly the commonly used instrument among surveys, is the questionnaire”. Walker (1990, p. 91) described the questionnaire as “a formalized and stylized interview presented as transcripts with answers missing”. If the possibility of respondents misinterpreting the questions is minimised, the questionnaire has many advantages such as more truthful responses, more diverse locations, and less bias (Ary et al., 2002). Best and Kahn (1998) stated that:

The survey is an important type of study. It must not be confused with the mere clerical routine of gathering and tabulating figures. It involves a clearly defined problem and defined objectives. It requires expert and imaginative planning, careful analysis and interpretation of the data gathered, and logical and skilful reporting of the findings (p. 116).

It is seen that designing a good questionnaire takes a great deal of time, ingenuity, and hard work. Best and Kahn (1998, p. 116) also claimed that “the questionnaire has unique advantages, and properly constructed and administered, it may serve as a most appropriate and useful data gathering device in a research project”.

In this study, the questionnaires are adapted from five projects conducted in Australia, the U.S., the U.K. and Vietnam. These projects are:
- Strategic Programs for Innovations in Undergraduate Physics conducted by The American Association of Physics Teachers in 2003.
- Observation on Undergraduate Education in Computer Science, Electrical Engineering, and Physics at Selected Universities in Vietnam commissioned by the Vietnam Education Foundation in 2006.

A series of questions were carefully chosen from these projects’ and surveys’ reports and modified to suit the context of this research. The questionnaires were designed to survey the current undergraduate physics teaching and learning practices, challenges and changes in the practices, and future directions of the practices. The questionnaires, the letters of introduction to the research, and the invitation to the Vietnamese participants were translated into Vietnamese. These questionnaires were carefully tested by two Vietnamese physics lecturers studying PhD degrees at the University of New South Wales and La Trobe University.

There are two types of questionnaire in this research study. One questionnaire is designed to seek information from physics teaching staff and the other is designed for undergraduate physics students. The invitation letter and questionnaire for physics teaching staff are shown in Appendix A and those for undergraduate physics students are shown in Appendix B. The content of the questionnaires for staff and students are organised around the following themes:
- The background of the respondents
- The current undergraduate physics teaching and learning practices
- The challenges and changes in undergraduate physics practices in recent years
- The future directions of undergraduate physics teaching and learning practices
Particularly, the first part of the questionnaires is to obtain respondents’ information. To protect the confidentiality of the respondents, no identification of individual departments, members of staff, and students will be made in any report derived from these questionnaires. The second part of the questionnaires is the survey on current practices, challenges, changes, and future directions in teaching and learning of undergraduate physics in the studied universities.

3.3.2. The interviews

In this study, the interview is a research instrument to seek deeper information from the respondents and to strengthen and validate data collected by other methods. According to Cohen and Manion (1994), there are four kinds of interview that may be used specifically as research tools: the structured interview; the unstructured interview; the non-directive interview; and the focused interview. This study employs the structured interview with predefined set of questions because these questions might minimise the amount of irrelevant data. A non-direct interview technique was also used in my study to probe information from Vietnamese lecturers and students because in Vietnam people tend to avoid direct speaking for several reasons. Furthermore, group interviews with students were used in the study because according to Cohen and Manion (1994, p. 287), the group interview has “the potential for discussions to develop, thus yielding a wide range of responses”.

The interview in-depth questions for physics teaching staff and undergraduate physics students have been carefully developed based on the information on questionnaires with the aim to strengthen the data collected (Appendix C and Appendix D). The length of the interview with physics teaching staff was about thirty minutes with the themes concentrated on current practices, challenges, changes, and future directions of undergraduate physics teaching and learning practices in their physics departments and universities. The length of the interview with undergraduate physics students was about fifteen minutes probing their opinions on physics curriculum, physics teaching and assessment, and their learning experience. Additionally, this study interviewed several heads of physics departments and physics education innovators with the aims of getting more information on the research problems, strengthening the research data and further clarifying the data collected from lecturers and students.
These interviews’ in-depth questions were provided to the respondents in advance of the interviews. Prior to the interviews, permission to record the interviews was requested to ensure accuracy of the data collected for my study. In Vietnam, because the interviews were non-direct, information from the interviews with physics teaching staff and undergraduate physics students was transcribed in interview sheets and later translated into English.

3.3.3. The observations

This study used non-participant observation to observe undergraduate physics teaching and learning practices in lectures, tutorials and laboratory sections. According to Cohen and Manion (1994, p. 107), “non-participant observers stand aloof from the group activities they are investigating and eschew group membership”. There were three observations of physics lectures, three observations of physics tutorials, and three observations of undergraduate physics laboratories in each university in both countries. In addition, there were observations of undergraduate physics teaching and learning infrastructures, facilities, equipment, and resources in libraries and in the physics departments at these universities.

The observations aim to investigate: teaching approaches that teaching staff employ in their physics instructions; student learning strategies; the use of ICTs in teaching and learning; teaching staff and students’ activities in lectures, tutorials and laboratories; and the condition of teaching and learning infrastructure in these physics departments. All the observations were noted down in detail into observation sheets designed for different teaching settings.

3.3.4. Document collection and review

Because this study involves comparing undergraduate physics teaching and learning practices between the Australian and Vietnamese universities, documents from the universities in both countries, which include policy and strategic documents, physics course handbooks, mainstream physics curriculum, subjects’ syllabi, and laboratory manuals were collected. These documents were then reviewed to compare the Bachelor of Science majoring in physics (BSc PHY) provided in the Australian universities and the Vietnamese universities.
In Vietnam, because of its centralist culture, all higher education institutions are governed by the MOET in many aspects. Most degrees and courses provided in Vietnamese universities have to follow the guidance and standard set by the MOET. Therefore, the BSc PHY degree and the content of it, especially in the general stage as described in chapter 2, were expected to be quite similar.

3.3.5. The validity and reliability of the instrumentation

The validity and reliability of the instrumentation in this study were carefully considered because validity and reliability are used to judge how good a piece of research work is. According to Ary et al. (2002, p. 242), “validity is the extent to which scores on a test enable one to make meaningful interpretations. Reliability indicates how consistently a test measures whatever it does measure”. As describe in section 3.2.1, this study employed a triangulation technique in its data collection with the aim of improving the internal validity of the study. It also used both qualitative and quantitative research methods to improve the reliability of research findings because strengths of each method would complement weaknesses of the other.

In addition, in this study, the validity and reliability of the questionnaires were considered very important. Best and Kahn (1998, p. 310) state that basic to the issue of validity is “asking the right questions phrased in the least ambiguous way”. In other words, the questionnaire must be well designed in order that all respondents have a clear understanding of the kinds of information that researchers intend to get from them. In educational research, there are many methods to establish the validity of a questionnaire. For example, according to Ary et al. (2002),

The most obvious type of scientific validity evidence is based on content, which may be gathered by some competent colleagues who are familiar with the purpose of the survey examine the items to judge whether they are appropriate for measuring what they are supposed to measure and whether they are representative sample of the behaviour domain under investigation (p. 409).

Based on this criterion, the validity of the questionnaire of this study was ensured due to the fact that the development of this study’s questionnaires was based on five projects that were conducted in Australia, the U.S., the U.K. and Vietnam. The questionnaires were further validated by two Vietnamese undergraduate physics lecturers currently studying at Australian universities, who made comments on the
relevance of questions to the research questions, how clear were the questions, and how consistent was the content of the questionnaires.

3.4. Data Analysis

Because the questionnaires and interviews generate a large amount of data, as the first step the data in this study was organised and grouped collectively across categories. Descriptive statistical analysis was then applied to analyse the data collected from the closed response questions. According to Ary et al. (2002, p. 410), “surveys typically do not require complex statistical analyses. Data analysis may simply consist of determining the frequencies and percentages of responses for the questions of the study”. In this study the statistics used for the closed response questions involved only the calculations in percentages of the responses of the participants. For the open-ended questions, similar responses were grouped together and categorised according to the topic being surveyed. The data then was analysed using colour coding to identify the similar responses.

In this study, qualitative data was collected via observations, document analysis, and interviews with lecturers, students and innovators. The data collected from the document analysis and the observations was segmented. Each data segment was then allocated to categories which were crosschecked, refined and discussed in supervision team. The data from the interviews was coded by classifying material into themes and topics. The Australian universities, lecturers, students and innovators were coded as shown in Table 3.2.

<table>
<thead>
<tr>
<th>Subjects of study</th>
<th>Coded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities</td>
<td>A1, A2, A3</td>
</tr>
<tr>
<td>Lecturers</td>
<td>L1, L2, L3, ...</td>
</tr>
<tr>
<td>Students</td>
<td>S1, S2, S3, ...</td>
</tr>
<tr>
<td>Student Groups</td>
<td>SG1, SG2, SG3, ...</td>
</tr>
<tr>
<td>Innovators</td>
<td>I1, I2, I3, ...</td>
</tr>
</tbody>
</table>

Table 3.2: The codes of the subjects of study in Australia

The numbers in the codes are assigned based on the order of study. For example, the first lecturer being interviewed in the first Australian university that the study takes...
place is coded as A1L1 and the second lecturer in this university is A1L2. Similarly, the first student involved in this study at the first Australian university is coded as A1S1 and the second student in this university is A1S2.

Similarly, the codes of the subjects of study in Vietnam are shown in Table 3.3.

**Table 3.3:** The codes of the subjects of study in Vietnam

<table>
<thead>
<tr>
<th>Subjects of study</th>
<th>Coded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities</td>
<td>V1, V2, V3</td>
</tr>
<tr>
<td>Lecturers</td>
<td>L1, L2, L3, ...</td>
</tr>
<tr>
<td>Students</td>
<td>S1, S2, S3, ...</td>
</tr>
<tr>
<td>Student Groups</td>
<td>SG1, SG2, SG3, ...</td>
</tr>
<tr>
<td>Innovators</td>
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</tr>
</tbody>
</table>

For example, the first lecturer being interviewed in the second Vietnamese university of the study is coded as V2L1 and the second lecturer in this university is V2L2. Similarly, the first student involved in this study at the third Vietnamese university is coded as V3S1 and the second student in this university is V3S2.

### 3.5. Ethical consideration

In this study, ethical aspects of the research are carefully considered. Particularly, this study is conducted in a way so as to do no harm to individuals or groups. The data collected from this study is also reported exactly as obtained with no alterations made in them, and no exceptions made in the procedures by which they were collected. The researcher also ensured that participants in this study were informed accurately about the general nature of the research and any unusual procedures or tasks in which they were involved. In this study participants’ names have been kept confidential and they were not subjected to unusual discomfort or risk.

A file including the questionnaires, letter of information and invitation written in both English and Vietnamese, and an ethics approval application form completed with details of the purpose, nature and scope of the study, the proposed research methodology, the appropriate consideration of confidentiality issues, the security of data collected, and certification from the supervisors were submitted to Deakin University Ethics Committee prior to commencement of the research investigation.
3.6. Chapter summary

This chapter has described the research methodology employed in this study. In this study, both quantitative and qualitative research methods are employed. To make the study more reliable, a triangular technique has been used. Particularly, this study has sought information on undergraduate physics teaching and learning practices from physics teaching staff, undergraduate physics students and physics education innovators.

Multiple types of instrumentation including questionnaires, in depth interviews, and observations and document analysis are used in this study to collect data and to increase the validity and reliability of the instrumentation. The data collected from the instrumentation was segmented, organised and grouped collectively across categories by using colour coding of dialogues and the transcripts to identify the similar responses. Descriptive statistical analysis has been applied to analyse the data collected from the closed response questions.
Chapter 4. Comparison of the Structure of the Bachelor of Science Degree Majoring in Physics in Vietnam and Australia

Physics is considered a fundamental science and the physics knowledge delivered at an undergraduate level tends to be quite standard internationally. The physics common degree offered in most countries to undergraduate students at university level is the Bachelor of Science with major in Physics (BSc PHY). The BSc PHY provided to students at universities throughout the world shares common aspects and the content of physics knowledge delivered at university level has not changed much over the last few decades. Nevertheless, depending on purposes of higher education, learning outcomes, and requirements of the degree, the BSc PHY provided in different countries and different universities has major differences such as its length of time to complete, details of its curriculum, and requirements of subject syllabi.

This chapter will investigate differences and similarities of the BSc PHY provided in three Vietnamese universities and the BSc PHY provided in three Australian universities. This chapter will also briefly investigate differences in physics teaching and learning in secondary school levels and educational policies and strategies developed by the two countries. The data of this chapter was collected by gathering documentation on course curricula, physics subjects’ syllabi, laboratory manuals, subject handbooks, and policies and strategies of development in the six studied universities in Vietnam and Australia. Qualitative data analysis methods which include descriptive, evaluative, and exploratory research methods were used to analyse the data for this chapter. The analysis was based upon the data from the collected documentation in the universities in both countries.

This chapter will begin with an overview of the BSc PHY degree provided by the three universities in Vietnam. An overview of the degree provided by the three Australian universities will be described in the next section. The final section of the chapter will highlight major differences and similarities of the degree between the Vietnamese universities and the Australian universities.
4.1. **Overview of the Bachelor of Science majoring in physics in Vietnam**

Most high-profile universities in Vietnam offer the BSc PHY or engineering degrees to students. Physics has traditionally been considered one of the most important subjects in the country. Even at lower levels of education such as junior and senior secondary schools, physics has a significant curriculum presence compared to other disciplines. Historically, only highly capable students were chosen to enrol in university physics courses in order to fulfil the demand of shortages of the technical labour force in and after the Vietnam War. Today, in Vietnamese general education, all students are compulsorily required to spend seven years studying physics as a separate subject at lower and upper secondary school levels. In order to continue to study physics and physics related areas at university level, secondary school graduate students have to pass a very strict national university entrant examination organised annually by the MOET and in most cases they must get a good score for physics along with two other compulsory subjects which are mathematics and chemistry.

4.1.1. **Overview of physics requirements in upper secondary school in Vietnam**

In Vietnam, beginning in lower secondary school at year six, physics becomes a separate subject alongside mathematics, chemistry, biology and other social science subjects. From year six, physics becomes a compulsory subject for all students until year twelve – the final year of general education in Vietnam\(^1\). Physics offered at upper secondary school (year 10 to year 12) is considered very important because it affects not only students who are going to choose physics related courses in higher institutions but it also affects all other students due to the fact that physics is usually one of six compulsory subjects that all Vietnamese students have to pass in a national upper secondary school graduation examination in order to gain a general education certificate – This is also known as high school diploma degree.

Furthermore, physics, mathematics and chemistry are three compulsory subjects in an annual national university entrance examination that students are required to pass in order to qualify for science related courses in universities. Traditionally, Vietnamese students are more likely to be considered as intelligent if they opt to study natural sciences.

\(^{1}\) Vietnamese lower secondary level includes grades 6, 7, 8, and 9 and upper secondary school level includes grades 10, 11 and 12.
science subjects. These students are called Group A students\textsuperscript{2} and they are usually got
guidance from their families to have a tendency to focus on learning mathematics,
physics and chemistry or biology as early age as the beginning in lower secondary
school. These Group A graduates will be qualified to work in some important
professionals such as economy, health sciences, army, construction, transportation and
communications, and information technology. Physics curricula provided in Vietnamese
secondary school levels have a comprehensive coverage of most aspects of physics
knowledge ranging from classical mechanics to modern physics such as particle physics,
nuclear physics, and quantum aspects of light. The following table shows standard
compulsory physics topics and time requirement that students have to complete in the
10\textsuperscript{th}, 11\textsuperscript{th}, and 12\textsuperscript{th} grades in upper secondary schools in Vietnam.

\textbf{Table 4.1.} Compulsory physics topics in upper secondary school in Vietnam

<table>
<thead>
<tr>
<th>Grade</th>
<th>Compulsory physics subjects</th>
<th>Face-to-face time</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>\textit{Kinetics}</td>
<td>70 hours</td>
</tr>
<tr>
<td></td>
<td>\textit{Dynamics}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Equilibrium and motion of a rigid body}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Conservation laws}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Gases}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Introduction to thermodynamics}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Solid and liquid. Transformation between solid and liquid}</td>
<td></td>
</tr>
<tr>
<td>11th</td>
<td>\textit{Charged particle. Electric field}</td>
<td>70 hours</td>
</tr>
<tr>
<td></td>
<td>\textit{Electric current}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Electric current in different environments}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Magnetism}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Magnetic Induction}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Light Refraction}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Optics of eyes. Optical instruments}</td>
<td></td>
</tr>
<tr>
<td>12th</td>
<td>\textit{Mechanical Oscillations}</td>
<td>70 hours</td>
</tr>
<tr>
<td></td>
<td>\textit{Mechanical waves and sound waves}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Alternative current}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Electromagnetic waves and Oscillations}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Light waves}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Quantum particle of light}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{Nuclear physics}</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{From microscopic to macroscopic world}</td>
<td></td>
</tr>
</tbody>
</table>

\textit{Source: Quang Binh Specialised Upper Secondary School (2009)}

\textsuperscript{2} National university entrance examinations are divided into groups based on the three compulsory
subjects. Group A students will take Mathematics, Physics and Chemistry in the examination.
As can be seen from Table 4.1, in three years of secondary school education, Vietnamese students have to learn at least twenty two physics topics and they have to sit for about 210 face-to-face contact hours in classrooms for physics subject. Alongside physics, the students have to study twelve other subjects required in each grade of upper secondary school level and the amount of knowledge and time requirement for each individual subject are to some extent similar to the requirement of physics. The physics curricula and all other subjects’ curricula used in secondary school levels in Vietnam are designed by the MOET and they are compulsorily applied for teaching in all Vietnamese secondary schools.

The comprehensive coverage of physics content knowledge in the upper secondary school physics curriculum might be taken to indicate that secondary school graduate students in Vietnam are likely to have good basic theoretical knowledge of a wide range of physics topics and also of other disciplines. Nonetheless, this issue of the large amount of content knowledge delivered in Vietnamese secondary schools has been a debate in Vietnamese educators for many years. Many educators have argued that the large amount of content and subsequent time requirement is one of the reasons contributing to rote learning as a common strategy used by students. In addition, the physics teaching and learning approaches that tend to drive students into mathematical manipulation instead of focusing on students’ conceptual understanding of physics, and a curriculum that lacks practical components and real life applications are also reported as common issues in physics teaching practices in Vietnamese secondary schools (Ng and Nguyen, 2006).

4.1.2. Requirements of physics bachelor degree in Vietnam

In Vietnam, not only general education levels but also higher education levels and vocational education are in many aspects under the management of the MOET. Particularly, the curricula of courses in individual university are designed based on curriculum standards released by the MOET. Recently, Vietnamese universities have been given their autonomy to develop their own curricula and courses but they must be censored and approved by MOET’s curriculum development authority. The operations of all higher education institutions must also act accordingly to instructions and
The guidelines stated in Higher Education Law. The law states that higher education institutions must aim at training learners to have:

- knowledge, research abilities and practical skills commensurate with professional qualifications;
- political and moral qualities;
- good attitudes of serving the people;
- innovative minds and professional responsibilities;
- good adaptability to an ever-changing work environment;
- good health to meet the requirements of building and protecting the homeland.

(The Congress of Vietnam, 2012, p. 1)

As a result, curricula of undergraduate physics provided in different Vietnamese universities share many similar features. Particularly, the BSc PHY in Vietnamese universities requires at least four years of full-time study to complete. Each school year is divided into two semesters and each semester has about 15 weeks for teaching and studying and 3 weeks for examinations and tests. Typically, students commencing BSc PHY from 2011 onwards must successfully complete at least 128 credit points in which:

- 30 credit points are for general knowledge that is compulsory to all students of different areas;
- 4 credit points are for social sciences;
- 28 credit points are for general science knowledge;
- 47 credit points are for majors
- 12 credit points are for specialised major subjects;
- and 7 credit points for a graduation thesis.

Because credit point system in the Vietnamese universities is different from the Australian universities, in order to make it easy for comparison, one credit point is converted to time equivalence in hour. In the Vietnamese universities, the time required to complete one credit point for different teaching activity is different. For example, one credit point required for teaching physics theory in lecture is equivalent to 15 hours, while that for teaching in laboratory is ranging from 30 to 45 hours. The credit point to time equivalence in hour is summarised in Table 4.2, and the number of credit points required for each kind of knowledge and its number of face-to-face contact hours are shown in Table 4.3.
Table 4.2. One credit point of teaching activities to time equivalence in hour

<table>
<thead>
<tr>
<th>1 credit point of</th>
<th>Equivalent to number of face-to-face contact hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching theories</td>
<td>15 hours</td>
</tr>
<tr>
<td>Practical work</td>
<td>30 – 45 hours</td>
</tr>
<tr>
<td>Discussion</td>
<td>30 – 45 hours</td>
</tr>
<tr>
<td>Tutorial</td>
<td>45 – 60 hours</td>
</tr>
<tr>
<td>Essay writing</td>
<td>45 – 60 hours</td>
</tr>
<tr>
<td>Community or Industrial placement</td>
<td>45 – 90 hours</td>
</tr>
</tbody>
</table>

Source: MOET (2007)

Table 4.3. The number of credit points required for kinds of knowledge and the degree

<table>
<thead>
<tr>
<th>Kinds of knowledge</th>
<th>No. of credit points</th>
<th>Equivalent face-to-face contact hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>General knowledge</td>
<td>30</td>
<td>529 hours</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>4</td>
<td>60 hours</td>
</tr>
<tr>
<td>General science</td>
<td>28</td>
<td>668 hours</td>
</tr>
<tr>
<td>Physics majors</td>
<td>47</td>
<td>1000 hours</td>
</tr>
<tr>
<td>Specialised subjects</td>
<td>12</td>
<td>226 hours</td>
</tr>
<tr>
<td>Minor thesis</td>
<td>7</td>
<td>315 hours</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>128</strong></td>
<td><strong>2,798 hours</strong></td>
</tr>
</tbody>
</table>

Source: University 1, Vietnam (2011)

The curriculum for BSc PHY in the Vietnamese universities commonly requires students to complete at least 52 compulsory and elective subjects plus a graduation thesis or graduation examination. In this curriculum, there are many subjects that are not related to physics or other physical science. For example, general knowledge and social sciences comprise more than a quarter of the time required for the curriculum, which include following subjects: Marxist – Leninist Philosophy, Marxist – Leninist Politics and Economics, Vietnamese Communist Party History, Scientific Socialism, Ho Chi Minh’s Idealism, Physical Education, English, and Country Defence Education.

In this curriculum, besides some standard classical physics and modern physics subjects, the curriculum includes a range of theoretical physics subjects which require high levels of mathematical skills such as Theoretical Mechanics, Electrodynamics, Quantum Mechanics, and Physics – Mathematics Equations. Therefore, students are provided four advanced mathematical subjects that include one algebra subject and three calculus subjects to improve their mathematical skills.
For comparison purposes, mechanics is chosen to provide an insight into differences and similarities in physics syllabi of the BSc PHY degree between the two countries. There are several reasons of choosing mechanics as a comparative topic between physics curricula provided in the Vietnamese universities and the curricula provided in the Australian universities. Firstly, mechanics is a compulsory subject delivered by all six studied universities in Vietnam and Australia. Secondly, mechanics is a standard subject and therefore it is expected that its content is not much different in the curricula from both countries. Thirdly, mechanics is also an important subject both theoretically and practically.

In Vietnam, the curriculum for a course and syllabi of physics subjects at university level must follow guidelines from the MOET. Therefore, mechanics as well as other physics topics provided in different Vietnamese universities usually share similar features. Table 4.4 summarises a typical syllabus of mechanics provided in the Vietnamese universities. As can be seen from Table 4.4, there are twelve chapters and the total face-to-face contact time in lectures and tutorials is 85 hours for the mechanics subject required by the Vietnamese universities.

Table 4.4. Summary of mechanics syllabus in Vietnamese universities

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Content of chapter</th>
<th>Lecture time</th>
<th>Tutorial time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Physics</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>2</td>
<td>Particle Kinematics</td>
<td>4 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>3</td>
<td>Particle Dynamics</td>
<td>4 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>4</td>
<td>Movement in Non-Inertial Frames of Reference</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>5</td>
<td>Work and Energy</td>
<td>4 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>6</td>
<td>System of Point Particles, Theorem of Conservation of Kinetic Energy, Vector Momentum of Particles</td>
<td>4 hours</td>
<td>6 hours</td>
</tr>
<tr>
<td>7</td>
<td>Rigid Bodies</td>
<td>5 hours</td>
<td>6 hours</td>
</tr>
<tr>
<td>8</td>
<td>Gravitational Force</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>9</td>
<td>Fluid Mechanics</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>10</td>
<td>Mechanical Oscillation</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>11</td>
<td>Introductory to Mechanical Waves</td>
<td>4 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td>12</td>
<td>Principle of Special Relativity</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
</tbody>
</table>

Source: University 1, Vietnam (2011)

One of the important components in physics teaching practices is the laboratory work. The practical work required for mechanics in the Vietnamese universities is listed in Table 4.5.
Table 4.5. Practical work required for mechanics

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement apparatus</td>
<td>- Using Calliper to measure sizes of a metal cylinder.</td>
</tr>
<tr>
<td></td>
<td>- Using Micrometer to measure the diameter of a marble.</td>
</tr>
<tr>
<td>Translational-rotation motion</td>
<td>- Investigate motion of a body that involves in translational motion and rotation at the same time.</td>
</tr>
<tr>
<td></td>
<td>- Determine moment of inertia of a rotating wheel and friction force at bearings based on the conservation law of mechanical energy.</td>
</tr>
<tr>
<td>Oscillation of physics pendulum</td>
<td>- Investigate the oscillation of physics pendulum.</td>
</tr>
<tr>
<td></td>
<td>- Determine the gravitational acceleration g.</td>
</tr>
<tr>
<td>Resonance of standing waves</td>
<td>- Determine wavelength and speed of sound in the air by resonance of standing waves method.</td>
</tr>
<tr>
<td>Viscous coefficient of fluid</td>
<td>- Determine viscous coefficient $\eta$ of fluid using Stokes method.</td>
</tr>
<tr>
<td>Molecular heat of gas</td>
<td>- Determine the ratio of molecular heat $C_p/C_v$ of gas</td>
</tr>
</tbody>
</table>

Source: University 1, Vietnam (2011)

The aim of mechanics syllabus is to provide students the basic knowledge of mechanics as a foundation to continue studying other advanced physics subjects. Generally, requirements of mechanics as well as other subjects in Vietnamese universities are somewhat similar. Particularly, Vietnamese students are required to attend lectures and tutorials regularly, physics lecturers and physics departments’ staff have responsibility of calling the role of students in lectures, tutorials and laboratory sessions. Students are expected to focus on listening and writing all information delivered by lecturers in lectures and tutorials. They are also expected to complete all homework problems and be able to remember and re-do them on the blackboard at tutorial sessions. Mid-term and end-term examinations are usually strict and require students to remember all formulae and mathematical equations and derivations.

In physics laboratory, students are required to complete all six experiments as a compulsory condition to pass the subject. They must also prepare a report prior to each experiment, in which students summarise theoretical principles of the experiment, aims of the experiment, processes and steps of performing the experiment. Students then, before being allowed to enter the laboratory, have oral tests for about five minutes and their preparations must be checked by two lab demonstrators. In the process of performing each experiment, students are expected to follow instructions in the
laboratory manual and from demonstrators. After finishing six experiments, all students have to attend an experimental examination which aims to check students’ understanding of theories as well as their practical work skills. Students who fail this examination are also considered to fail in mechanics (University 2, 2011).

Teaching and learning materials and resources in these Vietnamese universities are mainly from hard copy sources such as textbooks and lecture notes. Lecturers’ preparation of lecture notes is compulsorily required to all lecturers in Vietnamese universities and it is periodically checked by physics departmental staff. These lecture notes are usually prepared as hard copies and in many cases these notes might replace subjects’ textbooks. Most Vietnamese students have copies of textbooks and lecture notes as well as laboratory manuals. Electronic resources are not sufficient and usually written in English. In three studied universities, only one university had available online lecture notes of mechanics for students to download.

In assessment process, students are required to attend at least 80% of contact time in class in order to pass the subject and there are three kinds of assessment for the subject, which are:

- Regular assessment (comprising 15% of the total mark): to assess students’ abilities of memorising and applying basic knowledge of mechanics via their ability to solve medium-hard problems.

- Mid-term examination (comprising 25% of the total mark): to assess students’ skills in independent study and presentation.

- End-term examination (comprising 60% of the total mark): to assess students’ physics knowledge and their skills in connecting theory to its application.

In brief, the BSc PHY in the Vietnamese universities requires 4 years of full time study to complete. Students enrolling in this course have studied an extensive amount of physics at secondary school levels. To complete the BSc PHY degree, students are required to complete at least 128 credit points that are equivalent to a minimum of 2,798 face-to-face contact hours. Undergraduate physics curriculum includes more than 52
subjects that students have to learn and pass, many of them are not related to physics and many of them require advanced mathematical skills to be able to understand and solve problems.

In lectures and tutorial sections, students are expected to focus on listening and writing all information delivered by lecturers. They also have to complete all experiments required for the degree and pass of all experimental examinations are compulsory condition. Regularly going to lectures and tutorials with a minimum attendance of 80% is compulsory for all students to be considered as satisfactory academic progress. Students’ knowledge is evaluated via regular assessment (20%), mid-term examination (20%) and end-term examination (60%).

4.2. Overview of the BSc PHY degree in three studied universities in Australia

Physics plays an important role in Australian frontiers of research such as medicines, new materials, and nanotechnology. In Australia, there are 26 universities providing physics degrees accredited by the Australian Institute of Physics (Mills et al., 2005). Most of the credited programs are the BSc PHY and double degrees. Students enrolling in physics courses at university level are chosen based on their VCE results and not necessarily required to complete all physics units at year 12. This section provides details of requirements of the BSc PHY degree at three studied universities in Australia.

4.2.1. Overview of physics requirements in Australian upper secondary schools

In Australia, secondary school curricula vary from state to state. This study has chosen the Victorian secondary school system to study mainly for reasons of convenience. The Victorian education system is well regarded within Australia and the Victorian Certificate of Education (VCE) is recognised by education systems, universities and employers around the world (DEECD, 2013). In the Victorian school system, physics is integrated into a general science subject that is taught from Level 1 (Prep) to Level 6 (Years 9 – 10) and it becomes a separate subject in year 11 and year 12. The general aim of the science subject in Victorian schools is to ensure students are familiar with everyday life science phenomena and are able to explain basic science concepts and phenomena such as the role of DNA and genes, natural selection and
evolution, the origin and evolution of the Universe, the relationship between force, mass and movement, etc (VCAA, 2010).

The VCE Physics course aims to provide a foundation for students who will progress to study physics or physics based disciplines at tertiary level, and contributes to a general education for others who are interested in the subject. Physics at year 11 and year 12 is divided into four units. Unit 1 focuses on Physics as a human endeavour. It provides students with observations and ideas about aspects of energy in the physical world. Physics in Unit 1 includes Nuclear physics and Radioactivity, Electricity, and one of the following six detailed studies: Astronomy, Astrophysics, Energy from the nucleus, Investigations: flight, Investigations: Sustainable energy sources, and Medical physics (VCAA, 2010). In Unit 2, students study Motion, Wave-like properties of light, and one of the six detailed studies listed above but different from the one chosen in Unit 1. Unit 3 consists of Motion in one and two dimensions, Electronics and photonics, and one of the following subjects: Einstein’s special relativity, Materials and their use in structures, and further Electronics. In Unit 4, students study Electric power, Interactions of light and matter, and one of the following studies: Synchrotron and its applications, Photonics, and Sound. The topics required for students to study at upper secondary school in Victoria are listed in Table 4.6.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Unit</th>
<th>Compulsory Subjects</th>
</tr>
</thead>
</table>
| 11    | Nuclear Physics and Radioactivity  
      | Electricity  
      | One of the following: Astronomy, Astrophysics, Energy from the nucleus, Investigations: Flight, Investigations: Sustainable energy sources, and Medical physics |
| 12    | Motion  
      | Wave like properties of light  
      | One of the following studies but different with that in Unit 1: Astronomy, Astrophysics, Energy from the nucleus, Investigations: Flight, Investigations: Sustainable energy sources, and Medical physics |
| 3     | Motion in one and two dimensions  
      | Electronics and Photonics  
      | One of the following subjects: Einstein’s special relativity, Material and their use in structures, and Further electronics |
| 4     | Electric power  
      | Interactions of light and matter  
      | One of the following: Synchrotron and applications, Photonics, Sound |
As can be seen from Table 4.6, there are twelve physics topics in the Victorian secondary school physics curriculum and most topics are closely related to real life contexts. The physics curriculum at the secondary school level in Victoria focuses on student activities such as observations of everyday physics phenomena, explorations of applications of physics to everyday situations, and investigations of contributions of physics to the development of technologies and communication (VCAA, 2010). It also aims to develop students’ practical skills, problem solving skills and thinking skills by requiring students to “design and carry out investigations, collect accurate data, evaluate the quality of data and measurement processes and make conclusions based on the data” (VCAA, 2010, p. 4).

4.2.2. Bachelor of physics degree in Australia

The BSc PHY degree provided in three Australian universities requires students to take at least three years of full-time study to complete. Its objectives are to provide students with a range of knowledge and skills necessary for their future career as scientists or engineers. The following example shows the aims of the degree provided by Australian university 3, which is broadly representative of the Australian perspective. Particularly, on completion of the BSc PHY students will:

- have a clear understanding of how physics knowledge is constructed, and appreciate the importance of physics in everyday life, in technologies, and in the structure of the universe;
- have an understanding of classical physics (mechanics, electromagnetism, waves and optics), the foundations of quantum, atomic, condensed matter and statistical physics, and some aspects of contemporary physics knowledge and practice;
- be able to apply physics concepts in these areas with appropriate mathematical methods to a range of situations, and demonstrate problem solving and critical thinking skills;
- have acquired computational and IT skills, an ability to plan experiments, and experimental skills including the effective use of a range of scientific instruments, measurement, data analysis, and analysis of uncertainties;
- have developed, in the context of discipline, the graduate attributes of effective communication, quantitative literacy, information and communication literacy, inquiry and critical thinking;
- have developed an understanding of the ethical, social and international perspectives of the discipline;
- know the key principles underlying occupational health and safety in laboratory practice;
- have a foundation for further learning in physics and related disciplines, for employment requiring analytical, quantitative and experimental skills, and for undertaking secondary physics teacher qualifications.

(University 3, 2011, p. 1)

In Australia, there is a variation in the way of defining credit points at each university. Table 4.7 compares the equivalent full time student load (EFTSL) versus credit points among the three studied universities. The approximate average face-to-face contact time hour equivalence is calculated based on the average of the number of face-to-face contact hours required for 15 credit points for physics subjects at A1, 12.5 credit points for physics subjects at A2, and 6 credit points for physics subjects at A3.

<table>
<thead>
<tr>
<th>EFTSL</th>
<th>Credit points</th>
<th>Average contact hours equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>0.125</td>
<td>15</td>
<td>12.5</td>
</tr>
<tr>
<td>0.250</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>0.500</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>1.000</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

From the calculation, the typical BSc PHY degree in Australia requires students to spend about 1,872 face-to-face contact hours to complete the degree.

Table 4.8 lists subjects provided for the degree in Australian University 1, University 2 and University 3. The maximum total numbers of subjects that require students to study for their BSc PHY are 24 subjects over 3 years of full time study. Besides fundamental and basic physics subjects, advanced subjects provided to students are usually linked to the strength of research areas of each university.

---

3 EFTSL is a measurement of how much a subject is worth in a normal full time year.
4 Number of hours for 3 full time years = 624 hours (1 year full time) x 3 = 1872 hours
### Table 4.8. Science subjects and mathematics provided by universities 1, 2 & 3

<table>
<thead>
<tr>
<th>University</th>
<th><strong>Fundamental subjects</strong></th>
<th><strong>Advanced subjects</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Physics 1, Calculus 2, Physics 2: Physical Science &amp; Technology, Linear Algebra, Chemistry 1, Chemistry 2, Electromagnetism and Optics, Quantum Mechanics and Special Relativity, Thermal and Classical Physics, Real Analysis with Applications, Vector Calculus, Reaction and Synthesis, Complex Analysis, Computational Physics</td>
<td>Quantum Physics, Electrodynamics, Statistical Physics, Physics, Physics Lab A</td>
</tr>
<tr>
<td>A3</td>
<td>Physics 1, Physics 2, Physics for the living world, Physics, energy and the environment, Foundation physics, Physics: Quantum concepts and technologies, Physics: Electromagnetism, light and entropy, Foundations of contemporary physics, Photon physics, Fundamental particle physics, Theoretical physics 1, Theoretical physics 2</td>
<td>Astronomy, Physics for astrophysics, Observational astronomy, Functional materials and devices, Materials characterisation and modelling, Fundamental of condensed matter physics, Physics research project 1 &amp; 2</td>
</tr>
</tbody>
</table>

The common compulsory physics subjects for first year physics undergraduate students are Physics 1 and Physics 2 (or Principles of Physics A and Principles of Physics B as named by another university). Physics 1, for example, aims to provide students a broad range of physics principles and usually includes topics such as Classical
Mechanics, Waves, Optics, and Special Relativity. For example, table 4.9 shows details of topics and time commitment required for Physics 1 in the University 2.

**Table 4.9.** Details of topics taught in Physics 1 subject

<table>
<thead>
<tr>
<th>Topic</th>
<th>Content</th>
<th>Total contact time required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanics</td>
<td>Newton’s laws of motion for both translational and rotational</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy transfer and transformation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Momentum and impulse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simple harmonic motion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equilibrium</td>
<td></td>
</tr>
<tr>
<td>Waves</td>
<td>Water waves; Seismic waves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production and detection of sound</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ultrasound: reflection and refraction, superposition, resonance, energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>transport, absorption, Doppler effect</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>36 hours 12 hours 28 hours</td>
</tr>
<tr>
<td>Optics</td>
<td>Optical imaging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sensors and optical instruments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Human vision</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crystallography: dispersion, lenses and mirrors, interference, diffraction,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>polarisation</td>
<td></td>
</tr>
<tr>
<td>Special Relativity</td>
<td>The ‘twin paradox’: Einstein’s modification of Newtonian physics,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>relativity of time and space, equivalence of mass and energy</td>
<td></td>
</tr>
</tbody>
</table>

Physics subjects required for the degree offered at Australian universities generally incorporate practical work as part of their syllabi because laboratory work is considered as an important and essential part of undergraduate physics. The Physics 1 subject outlined above requires students to perform in the laboratory for eight weeks of
three hour laboratory sessions per week. Table 4.10 is an example of practical work requirements that students have to complete in studying Physics 1 in Australian University 2.

Table 4.10. Practical work required for Physics 1 in University 2

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear motion and Newton’s laws</td>
<td>- Using DataStudio to explore the relationship between distance vs. time, velocity vs. time, and acceleration vs. time graphs; Investigate Newton’s laws.</td>
</tr>
<tr>
<td>Relativity and particle physics</td>
<td>- Give students some experience with relativity and simple particle physics by playing with computer application. - Determine the life time of a charmed meson and measure the mass of a top quark.</td>
</tr>
<tr>
<td>Simple harmonic motion</td>
<td>- Investigate the theoretical principles and physical properties of springs; Measure a spring constant in equilibrium. - Explore the behaviour of a simple spring and investigate the principles of simple harmonic motion. - Observe basic simple harmonic motion, and investigate the conservation of energy in simple harmonic motion.</td>
</tr>
<tr>
<td>Vibrations in an air column</td>
<td>- Investigate the example of sound waves - Investigate the pattern of resonant frequencies, and determine the speed of sound.</td>
</tr>
<tr>
<td>Rotational motion</td>
<td>- Investigate the properties of rotating objects - Measure the moment of inertia of a wheel and investigate the energy aspects of rotation.</td>
</tr>
<tr>
<td>Thin films</td>
<td>- Investigate the phenomenon of interference, principles of colourful patterns on thin film.</td>
</tr>
<tr>
<td>Thin lenses Polarisation of light</td>
<td>- Investigate behaviour of lenses and the concept of magnification. - Give students experience in making and recording observations of phenomena in a logical way.</td>
</tr>
</tbody>
</table>

These laboratory sections run parallel to the lectures and tutorials with the aims of relating theories learnt to practice. Students are required to do pre-lab exercises involving reading manual instructions, answering exercises, and completing on-line questions. In A2, for example, pre-lab exercises contribute 20% to students’ final mark for practical work and the remaining 80% contribution to the mark is results of students’ performance in the laboratory. The total laboratory assessment makes up 25% of students’ final mark for the subject. The remaining 75% of the subject final mark is contributed by: 10% of two mid-term examinations, 5% of a four hour written assignment outside class time, and 60% of three hour end-term examination.
4.2.3. **Summary**

The BSc PHY degree in the Australian universities requires at least 3 years of full time study to complete. The common prerequisites for students enrolling in the course are VCE Unit 3 and 4. To gain the degree, students must complete 360 credit points in the University 1 credit point system, or 300 credit points in the University 2 credit point system, or 144 credit points in the University 3 credit point system. This is equivalent to a maximum of 1,872 face-to-face contact hours in each case. In all the three universities, the number of subjects that students have to study is 24 subjects, in which at least 6 subjects are elective. First year physics subjects usually incorporate many topics and the practical work is run parallel to lectures and tutorials. Commonly, in these three universities, students’ final mark for a subject is contributed to by 25% of laboratory results, 10% of two mid-term examinations, 5% of written assignment, and 60% of final examination.

4.3. **A comparison between the BSc PHY degree offered in the Australian universities and in the Vietnamese universities**

The BSc PHY degree offered in the three Vietnamese universities and the three Australian universities share typical features of their physics curricula. Standard subjects such as mechanics, electromagnetism, waves and optics, and quantum mechanics are delivered to students in these universities. Activities typical to physics teaching and learning practices such as lectures, tutorials, and experiments are also provided in the six universities in the two countries. Nonetheless, there are many noticeable differences in the aims, objectives, and requirements for the course as well as for individual subjects.

4.3.1. **The different levels of preparation from secondary schools**

At secondary school levels, Vietnamese students spend seven years (from year 6 to year 12) on studying physics as a separate subject while students at Victorian secondary schools study physics as a separate subject only at year 11 and year 12. Physics curricula and programs at secondary school levels in Vietnam provide a comprehensive coverage of most aspects of physics knowledge, from classical mechanics to modern physics such as particle and nuclear physics and quantum aspects
of light. Vietnamese students are required to spend a lot of time on solving physics exercises and problems.

On the other hand, at year 6 to year 10, students in Victoria in particular and in Australia in general study physics as part of an integrated topic in a science subject, in which students learn basic physics concepts such as the nature of forces and motion, and matter and energy. Physics at year 11 and year 12 in Victorian secondary schools includes physics topics such as nuclear physics and radioactivity, electricity, astronomy, motion and light, electronics and photonics, special relativity, materials, electric power, photonics, and sound. The content of the topics are closely related to real life situations.

There have been many studies showing that students who have studied physics at secondary levels perform better in undergraduate physics course than their non-secondary school physics peers (Hart and Cottle, 1993). These studies seem to support an argument that students in the Vietnamese context are adequately prepared for studying physics courses in higher education institutions because Vietnamese secondary schools seem to deliver a substantial amount of physics content involving more specified physics knowledge. Vietnamese students seem to spend a lot of time on working with physics formulae and mathematical manipulation while Australian students focus on exploring and investigating applications of physics knowledge into real life contexts.

In fact, in Vietnam, secondary school physics curricula, physics text books, the knowledge content and the time distribution to each chapter, each topic are nationally standardised by the MOET. Although curricula at secondary school levels in Vietnam have recently been changed to reduce the number of compulsory topics, the curriculum for physics at upper secondary school level as can be seen in Table 4.1 still covers many topics in details and has a large amount of physics content compared to the physics curriculum of the Australian secondary school level.

In addition, according to a recent report from UNESCO, “the Vietnamese upper secondary school curriculum content still mainly emphasises rote learning and does not help secondary students develop more problem-solving skills and analytical abilities” (UNESCO-IBE, 2011, p. 18). Moreover, teaching, learning, and assessments and evaluation are mainly for the purpose of driving learners to mechanical memory.
(MOET, 2001) and teaching and learning in Vietnamese secondary schools focus on examinations (Hoang, 2012). Ng and Nguyen (2006) also shows that physics teaching at several upper secondary schools in Vietnam lacks practical components and real life examples and applications but focuses students on solving numerical problems.

On the other hand, one of the aims of the Australian science curriculum is to provide students opportunity to “experience the joy of scientific discovery and nurture their natural curiosity about the world around them” (ACARA, 2013, para. 3). This is clearly illustrated in science subjects where students have opportunities to explore physics knowledge via interesting topics such as the origin and evolution of the Universe, and the relationship between force, mass and movement. Similarly, the physics curriculum at the Victorian upper secondary school level aims to develop students’ practical skills, problem solving skills and thinking skills by requiring students to “design and carry out investigations, collect accurate data, evaluate the quality of data and measurement processes and make conclusions based on the data” (VCAA, 2010, p. 4). At year 11 and year 12 in Victorian secondary schools, physics students are expected to be as scientists in the process of learning physics. Particularly, students are required to be involved in recording raw qualitative and quantitative data in laboratory and analysing those data to draw relevant conclusions. In contrast, very few experiments are performed at secondary school levels in Vietnam (Ng & Nguyen, 2006).

In summary, the two approaches in physics teaching at secondary school levels show the different levels of preparation for students going to study physics at tertiary level. Vietnamese secondary school students seem to be well prepared in mathematics, physics problem solving, and a wide range of detailed physics knowledge but they are not adequately provided with practical skills and the knowledge of physics applications. On the other hand, although the Australian secondary school curricula seem not to provide students detailed specified physics content knowledge at high level of mathematics, the curricula provide students opportunities to explore and investigate physics knowledge in real life contexts. As a result, Australian students are likely to have sound knowledge of the relation between physics and real world applications and good practical skills. These differences in the preparation of incoming undergraduate
physics students are likely to affect the practice of undergraduate physics teaching and learning between the universities in Vietnam and the universities in Australia.

4.3.2. The different objectives and outcomes of the BSc PHY Degree

Because the content of theoretical and experimental physics courses at undergraduate level tends to be quite standard internationally, it is expected that the objectives and the outcomes of the BSc PHY degree in different countries share similar features. In fact, the BSc PHY degree provided in the Vietnamese universities and the Australian universities share common objectives and outcomes. To illustrate, table 4.11 lists basic common objectives and outcomes of the degree provided in V3 and A3 as a comparative example.

Table 4.11. The common objectives and outcomes of the Degree in the Vietnamese university 3 and the Australian university 3

<table>
<thead>
<tr>
<th>Objectives of the BSc PHY of V3</th>
<th>Objectives of the BSc PHY of A3</th>
</tr>
</thead>
<tbody>
<tr>
<td>have knowledge of general physics, theoretical physics, experimental physics, mathematical methods for physics; have comprehensive knowledge in the fields of quantum physics, solid-state physics, optics-spectroscopy, informatics physics, electronics and telecommunications</td>
<td>have an understanding of classical physics (mechanics, electromagnetism, waves and optics), the foundations of quantum, atomic, condensed matter and statistical physics, and some aspects of contemporary physics knowledge and practice</td>
</tr>
<tr>
<td>have ability to present information logically, accurately and clearly and to analyse and evaluate issues based on evidence and scientific principles and build logical arguments in physics research</td>
<td>have developed, in the context of discipline, the graduate attributes of effective communication, quantitative literacy, information and communication literacy, inquiry and critical thinking</td>
</tr>
<tr>
<td>have ability to use mathematical knowledge in physics research; have ability to apply physics concepts and principles to study specialise fields of physics (quantum physics, solid-state physics, optics-spectroscopy); have ability to understand physics problems and know how to apply appropriate principles in solving physics problems</td>
<td>be able to apply physics concepts in these areas with appropriate mathematical methods to a range of situations, and demonstrate problem solving and critical thinking skills</td>
</tr>
</tbody>
</table>
Objectives of the BSc PHY of V3 | Objectives of the BSc PHY of A3
---|---
have knowledge of basic science to be able to master professional knowledge; have good skills in quantifying the experimental data and analysing quantitative problems | have a foundation for further learning in physics and related disciplines, for employment requiring analytical, quantitative and experimental skills, and for undertaking secondary physics teacher qualifications
have computational and IT skills to support research in physics | have acquired computational and IT skills

It can be seen from the Table 4.11, the degree provided in these two universities in Vietnam and in Australia have many common objectives and the outcomes. Particularly, they both aim to provide students with basic knowledge of classical physics and the foundation of modern physics such as quantum physics, solid-state physics, optics-spectroscopy, atomic physics, condensed matter and statistical physics, etc. To be offered the degree, students in these two universities are required to be able to apply physics knowledge, mathematical methods, IT skills into their professionals, and to be able to think critically, build logical arguments, and communicate effectively and logically in their further physics research and in their future professions.

However, in a deeper analysis, because of differences in culture, in political viewpoints and policies, and in expectations of graduate students, there are noticeable differences in the objectives and the outcomes of the BSc PHY graduate students in these two universities in particular and in undergraduate physics education between the two countries in general. Especially, due to the centralised policy in the Vietnamese Government, the Vietnamese universities do not have much freedom in making their own policies and strategies of training their students based on their strengths while the Australian universities have their power in decision making. Hence, physics departments in the Australian universities have their own initiative to utilise and maximise strengths of their research and existing facilities and resources.

Especially, the major difference in objectives and outcomes of the degree in the two countries is likely to be arisen from the fact that all Vietnamese higher education graduates are expected to have the political knowledge. These viewpoints as stipulated by the MOET include basic principles of Marxism-Leninism, the revolutionary
principles and policies of the Vietnamese Communist Party, Ho Chi Minh’s idealism, physical education, and national defence education. Additionally, as indicated in section 4.1.2, all undergraduate courses in Vietnam must follow the guidelines of the Vietnamese Education Law No. 38/2005/QH11 and the Vietnamese Higher Education Law. According to these laws, one of the goals of Vietnamese education is “to educate the Vietnamese into comprehensively developed persons who possess ethics, knowledge, physical health, aesthetic sense and profession, loyal to the ideology of national independence and socialism...” (The Congress of Vietnam, 2012, p. 2). Therefore, the Vietnamese education system at all levels is expected to train students to be complete persons who possess principle knowledge of chosen disciplines and all other qualities.

In contrast, the Australian universities focus on training graduate students who are expected to have good knowledge on specific discipline and to be able to apply the knowledge into real life situations and in their workplace. Particularly, the objectives and the outcomes of the degree provided in A3 at one part state that graduate students are expected to “have a clear understanding of how physics knowledge is constructed, and appreciate the importance of physics in everyday life, in technologies, and in the structure of the universe”. Furthermore, acquiring practical skills, occupational health and safety is also a very important aspect in training policies of the Australian universities. The Australian university 3, for example, expects student to:

- know the key principles underlying occupational health and safety in laboratory practice;

- have an ability to plan experiments, and experimental skills including the effective use of a range of scientific instruments, measurement, data analysis, and analysis of uncertainties.

In conclusion, the Vietnamese universities and the Australian universities have many common objectives and outcomes of the BSc PHY degrees. The similarities in objectives of the physics degree reflect a fact that physics is a fundamental science and its courses at an undergraduate level are quite internationally standard. However, because of differences in purposes of physics education and of university education
generally between the two countries and in social expectations of graduate students, there are dissimilar objectives and outcomes of BSc PHY courses provided by the Vietnamese and the Australian universities. Vietnamese universities’ physics courses tend to produce “complete” graduate students with wide range of knowledge and socialist ideology whereas Australian education is separate from politics and undergraduate physics courses aim to train students to be able and ready to work in the workplace environment.

4.3.3. The different subject and time requirements for the BSc PHY degree

Because the aims and objectives of the Vietnamese higher education are to train complete people, curricula of all undergraduate courses in general and of the BSc PHY degree in particular in the Vietnamese universities must embrace all the political and social science subjects required by the Vietnamese Government. The addition of these political and social science subjects into physics curriculum is one of the main reasons why physics students in the Vietnamese universities have to complete well over double the number of subjects required in the Australian universities to gain the same degree. Particularly, as described in previous sections, to get BSc PHY degree, Vietnamese students in the V1 have to study totally at least 52 subjects in comparison with a maximum of 24 subjects required by the Australian universities (Figure 4.1).

![Figure 4.1. Subject requirements for the degree in Australian and Vietnamese universities](image-url)

The Figure also shows that the number of non-physics subjects is at least 15 in the Vietnamese curriculum while the Australian students can choose a maximum
number of 6 elective subjects outside physics to study. The Vietnamese curriculum also has 6 elective subjects but all of these elective subjects belong to physics areas. As a result, the number of compulsory subjects that undergraduate physics students have to learn for the degree in the Vietnamese university is 46 compared to 18 subjects in the Australian curriculum.

Interestingly, although the Vietnamese students have to study one year more than the Australian students in order to gain the same undergraduate degree in physics, they have to study an average of at least 13 subjects in a year compared to an average of 8 subjects annually for the Australian students. In addition, while the Australian students have to complete totally 26 subjects less than the Vietnamese peers, they are able to choose the same number of elective subjects as in the Vietnamese curriculum requirement. These numbers show that undergraduate physics curriculum provided by Vietnamese universities have too many compulsory subjects and few electives. As a result, students do not have many opportunities to learn knowledge that is useful to their future careers.

Thus, the greater number of subjects required for the BSc PHY degree in the Vietnamese universities means a greater amount of contact time that the Vietnamese students have to spend to get the degree. As can be seen from Figure 4.2, the average of the total face-to-face contact time that Vietnamese students in the three studied universities have to spend to complete the degree is about 2,789 hours while that number of the Australian students is about 1,872 hours.

**Figure 4.2.** The total contact hours required for completion of the degree
The large number of subjects and amount of time required to complete the BSc PHY degree in the Vietnamese universities probably makes Vietnamese undergraduate physics students work harder than their Australian peers to earn the physics degree. Nevertheless, the Vietnamese students might not have enough time to study physics in depth and hence it might be another reason that contributes to the rote learning in students and lecturers’ teaching approaches that focus on theoretical knowledge. Additionally, a large number of non-physics subjects in the physics curriculum might make students feel irrelevant to the science degree that they are learning. In contrast, focusing on fundamental physics subjects that are relevant to the degree as in the Australian universities’ physics curriculum probably give students opportunities to learn physics knowledge in depth.

4.4. Chapter Summary

The physics Bachelor degree provided in the Vietnamese universities and the Australian universities shares common aspects. Fundamental physics subjects such as Mechanics, Heat and Thermodynamics, Electromagnetism, Optics, and some areas of Modern physics are included in the course’s curricula in both the Vietnamese and the Australian universities. There are also some similarities in general objectives and the outcomes of the degree between the universities in both countries. Specifically, the degree aims to provide students basic knowledge of classical physics and foundation of modern physics. The graduates are expected to be able to apply physics knowledge, mathematical methods, IT skills into their professionals, to be able to think critically, and to communicate effectively.

The comparison also reveals that the degree provided by the universities in both countries has noticeable differences. Table 4.12 summarises the differences in the requirements in order to complete the degree between the Vietnamese universities and the Australian universities.
Table 4.12. Differences in requirements of the BSc PHY degree

<table>
<thead>
<tr>
<th></th>
<th>Vietnam</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite of the degree</td>
<td>- 7 years secondary school physics</td>
<td>- 2 years secondary school physics</td>
</tr>
<tr>
<td></td>
<td>- Pass national university entrance examination</td>
<td>- Complete VCE units 3 and 4</td>
</tr>
<tr>
<td>Time to complete the degree</td>
<td>4 years</td>
<td>3 years</td>
</tr>
<tr>
<td>Face-to-face contact hours</td>
<td>2,798 hours</td>
<td>1,872 hours</td>
</tr>
<tr>
<td>No. of subjects required</td>
<td>52</td>
<td>24</td>
</tr>
<tr>
<td>No. of compulsory subjects</td>
<td>46</td>
<td>18</td>
</tr>
<tr>
<td>No. of elective subjects</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Subjects not related to physics</td>
<td>15</td>
<td>≤ 6</td>
</tr>
</tbody>
</table>

As can be seen from the table, in order to have a Bachelor degree in physics in the Vietnamese universities, students have to spend a lot more time, complete more compulsory subjects and less elective ones compared to the degree requirements in the Australian universities. The physics curricula and all higher education courses in general in Vietnam have to embrace political related subjects while Australian undergraduate physics curricula are free from the influence of any factors outside the requirements of the degree and focus on fundamental physics subjects and physics areas that are the strengths of individual department of physics.

Furthermore, because of the differences in purposes of physics education and of university education in general, there are different objectives and outcomes of the degree between the two countries. The Vietnamese universities’ BSc PHY degree aims to train “complete” graduate students who possess principle knowledge of chosen disciplines and all other qualities such as ethics, knowledge, physical health, aesthetic sense and profession, and loyal to the ideology of national independence and socialism. In contrast, Australian physics courses mainly aim to train physics graduate students who have basic knowledge of physics and are able to improve and apply the knowledge to everyday situations and in their future workplace.

These differences in the requirements of the degree are likely to lead to differences in the approach to undergraduate physics teaching and learning practices, in the two countries. In Vietnam, the large amount of content coverage implied by the detailed specified physics knowledge required by the curriculum raises the issue that this may affect lecturers’ teaching approaches. Arguably, high content coverage may lead to traditional teacher-centred teaching and hence encourage student shallow learning.
behaviour. In Australia, the lesser amount of content specification potentially gives lecturers more time to focus on in-depth knowledge of physics topics and applications of the knowledge, giving students opportunities to learn physics in a meaningful way and to understand physics knowledge in relation to everyday situations. These speculations will be investigated in the next chapters.
Chapter 5. Observations of Undergraduate Physics Teaching and Learning Practices at Selected Universities in Australia and Vietnam

Chapter 4 made a comparison of physics curricula from data collected via documents from three Australian universities and three Vietnamese universities. The comparison revealed major similarities and differences in the courses delivered by the six studied universities in the two countries. This chapter will further investigate the differences and similarities in undergraduate physics teaching and learning practices between the Vietnamese universities and the Australian universities by collecting data through observations of teaching and learning facilities and resources and of classroom activities in lectures, tutorials, and laboratories in these universities.

5.1. Observation of teaching and learning facilities and resources

As described in Chapter one, Australia is one of the wealthiest nations in the world and a leading country in the education sector. On the other hand, Vietnam is a developing country with inadequate educational infrastructure. Over recent years, the Vietnamese government and the MOET has invested heavily in education with the aims of improving educational facilities and instructional quality. Although there has been profound improvement in educational infrastructure, facilities and equipment, and resources, especially at the higher education level in recent years, Vietnamese teaching and learning facilities and resources are generally considered inadequate (Director et al., 2006). In contrast, Australian teaching and learning infrastructure, facilities and resources, especially at higher education level, are notably considered one of the world’s best. A recent University World News analysis ranked the Australian education system third in the world (Gerritsen, 2008).

In Australia, for example, the department of physics of the lowest nationally and internationally ranked university among the three studied universities in Australia has its infrastructure of a three-storey building with over 72 rooms including offices, classrooms, and laboratories. Most classrooms are equipped with projectors and computers connected to the Internet. The 1st year laboratory occupies over 500 square meters with 40 computers connected to the Internet, experimental instruments, and
printers. The university has a three-storey library occupying an area of about 15,000 square meters with about 650 spaces for independent study, about 60 study booths for individual or group study, about 60 spaces for group discussions and study, about 10 conferences and seminars rooms, and 3 audio-visual viewing rooms with 8 seats per room. There are about 230 computers with internet connection in the library. Students are able to access and download almost all journals in the world from the university computers without any fee.

The three studied universities in Vietnam have very good infrastructure and teaching and learning resources in comparison with other Vietnamese universities. For example, the V2 has a largest and the most modern electronic library in Vietnam and it has about 200 laboratories in which eight laboratories are national key research centres. However, students’ access to the Internet and the library resources is restricted. From my observation at the V2, 1st year physics students who had been studying for over four months at the university had not yet had access to the library because their student cards had not been issued. Access to computers and the Internet at the library is restricted by university rules and regulations. Computers with Internet connection in the library are restricted to a period of 60 minutes a day to users whose student cards must be checked by library staff. At the V1 library, students have to get permission from library staff in order to download studying materials from the Internet to flash drives.

Most of observed teaching and learning activities in the studied universities in Vietnam takes place in fixed classrooms. These classrooms’ arrangement follows a traditional style in which tables and benches are arranged into straight rows. These classrooms are also used for tutorial sessions. All of the classrooms that I observed at first year lectures and tutorials were poorly equipped with no projectors or computers. Whereas, most of the teaching and learning activities in the Australian universities took place in lecture theatres with modern equipment including computers connected to the Internet, projectors, and speakers. Especially, most of tutorial rooms in the Australian universities are equipped with multiple boards, projectors and computers, mobile tables and chairs convenient for group learning settings.

The laboratories in the three Australian universities are organised as research centres for students, which include many experiments from different fields such as
optics, waves/rotation, and mechanics for first year students. Experiments are concentrated in large halls in which there are large spaces for students to move around for discussions and for looking up physics references. All of the laboratories had safe work procedures, basic sanitary facilities, and protective clothing. Most of the experiments were well equipped with modern apparatus connected to computers and printers. Physics books, references and the Internet are available for students to look up for physics knowledge, formulae, and physics constants. Laboratory manuals are well documented and printed with specific instructions, physics knowledge, and methods of calculation and graphing.

In the Vietnamese universities, experiments are spread out in different rooms and areas because there are not enough spaces to arrange equipment and facilities into concentrated areas. Most of the first year physics laboratories in the three studied universities in Vietnam utilise normal classrooms therefore these laboratories seem not to have enough spaces for students to move conveniently around or to form groups for discussions. These laboratories also do not meet basic safe work procedures because there are no exit doors, fire extinguishers, and first aid equipment. In general, experimental apparatus is quite old and out of date. Most of the physics laboratories, especially the first year laboratories, do not have the Internet connection, printers, or physics books and references.

Generally, through observation of undergraduate teaching and learning facilities and resources at the Vietnamese and Australian universities, the physics departments in Australia have good facilities and resources in comparison with the physics departments in Vietnam. This was also the views of the physics lecturers and undergraduate physics students in both countries in in-depth interviews with them. Particularly, most of the physics lecturers and the students in the Vietnamese universities responded that the government and the universities needed to invest more on infrastructure, teaching and learning facilities and equipment while most of the Australian lecturers and the students were pleased with the current teaching and learning conditions at their departments and universities.

The observation shows that undergraduate physics students and lecturers in the Australian universities have advantages over the Vietnamese counterparts in terms of
utilising those facilities and resources into making the teaching and learning of undergraduate physics more effective. The next sections will examine how physics lecturers and students in the Australian universities take those advantages into their teaching and learning activities in lectures, in tutorial classes and in laboratory sessions. These sections will also further clarify the differences in teaching and learning facilities and resources between the universities in the two countries.

5.2. Observation of teaching and learning activities in lectures

The rationale for the comparative observation of classroom activities in lectures is to identify similarities and differences in teaching and learning methods of lecturers and students, to discover innovative features and effective methods of teaching and learning of undergraduate physics, and to find out how physics content is delivered in lectures in the Australian universities and the Vietnamese universities. The observation was of the in-class non-participant type and each observation of a lecture lasted for one hour. There were eleven observed physics lectures in the Australian universities and nine observed physics lectures in the Vietnamese universities. On the basis of these observed lectures in the Australian and Vietnamese universities, the following sections will examine similar and different features on teaching and learning facilities in lecture rooms, on teacher and student resources, and on teaching approaches of lecturers and learning strategies of students.

5.2.1. Lecture venues

Among eleven observed lectures in the Australian universities, ten lectures took place in lecture theatres and only one lecture took place in a normal classroom. The lecture theatres and the classroom in the studied universities had dedicated facilities such as tiered sitting, adequate lighting, heating, and ventilation. All the teaching and learning venues were equipped with audio-visual facilities which were computers connected to the Internet, projectors, transparent overhead-projectors, and speakers.

All nine observed lectures in the Vietnamese universities took place in traditional classrooms with inadequately equipped facilities. There were only two out of nine observed classrooms had speakers but none of them had computers and projectors. Most classrooms had tables and benches that were arranged in close rows. Benches in these
classrooms were designed to sit four students at most, but there were some benches in three observed classrooms sitting seven students.

5.2.2. Teaching and learning facilities and resources utilised in lectures

In addition to good infrastructure, adequate facilities and learning venues, the Australian students were provided adequate teaching and learning resources and a variety of teaching and learning facilities. Teaching staff utilised ICT facilities frequently in their lectures. Particularly, ten observed lectures in the Australian universities used PowerPoint presentations and one lecture used an overhead projector in teaching. In the process of delivering lectures, most observed lecturers used blackboards and chalk as additional means to expand mathematical formulae and to write down important points and explanations of physics knowledge. All lectures’ PowerPoint slides had graphics to illustrate physics content, in which there were four out of the eleven lectures using animations and simulations to show and explain physics knowledge and physics phenomena to the students. There were also three lectures using in-class live demonstrations which were set up prior to the lectures by technical staff. All the eleven lectures in the Australian universities had handout notes, of which five lectures had handout notes given at the lectures and in the other six lectures students had their printed lectures’ notes. Alongside printed physics textbooks and lecture’s notes, physics departments’ and universities’ websites provided online learning materials to students such as past examination papers, assignments, online quizzes, and pre-lab exercises.

In the observed Vietnamese universities, all nine Vietnamese lecturers used blackboards and chalk exclusively to present their materials to students. None had access to data projectors or internet facilities. Learning materials in the lectures at the Vietnamese universities were textbooks that students brought to their lectures. Almost all of the textbooks were photocopied ones with poor quality and with black and white graphics. There were also some groups of students sharing textbooks together to search for information that their lecturers were presenting. Among three studied universities, only one university had introductory physics lecture notes available for students to download from the university’s webpage.
Table 5.1 summarises the teaching and learning facilities and resources that the Australian lecturers and Vietnamese lecturers utilised in their undergraduate physics lectures.

**Table 5.1: Facilities and resources used in Australian and Vietnamese lectures**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Australian (11 lectures)</th>
<th>Vietnamese (9 lectures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using PowerPoint/overhead projector presentation</td>
<td>11/11 (100%)</td>
<td>0/9 (0%)</td>
</tr>
<tr>
<td>Integrate animations and simulations into lectures</td>
<td>4/11 (36.4%)</td>
<td>0/9 (0%)</td>
</tr>
<tr>
<td>Integrate live demonstrations in lectures</td>
<td>3/11 (27.3%)</td>
<td>0/9 (0%)</td>
</tr>
<tr>
<td>Lecture notes, handout</td>
<td>11/11 (100%)</td>
<td>0/9 (0%)</td>
</tr>
<tr>
<td>Blackboard or whiteboard, hand writing</td>
<td>0/11 (0%)</td>
<td>9/9 (100%)</td>
</tr>
</tbody>
</table>

The use of educational facilities and resources in classroom teaching suggests that the teaching in most Vietnamese observed lectures was still very much traditional with the extensive use of chalk and talk from the lecturers. In contrast, the Australian lecturers utilised available modern ICT facilities in their lectures, which would make the lectures more interesting and more relevant to students regarding the students’ knowledge and ability to use ICTs in today society.

5.2.3. Teaching and learning activities of lecturers and students in lectures

Vietnamese students are compulsorily required to attend 80% of total lectures for each subject and their regular attendance is counted towards their final marks of the subject. Particularly, the regular lecture attendance accounted for a maximum of 10% of the total mark of a subject. The common regulations of students’ lecture attendance in the Vietnamese universities are:

- If a student is absent for more than 20% of the number of lectures required for a subject, the student will have zero mark for the lecture attendance of that subject.

- If a student is absent for from 10% to 20% of the number of lectures required for a subject, the student will have 5 marks for the lecture attendance of that subject.
- If a student is absent for less than 10% of the number of lectures required for a subject, the student will have 10 marks for the lecture attendance of that subject.

Therefore, calling the roll of students is one of the regular tasks of Vietnamese lecturers in their lectures. In the observed lectures, at the beginning of seven lectures in the Vietnamese universities, lecturers called the roll of students. There were two remaining observed lectures in the Vietnamese V2, in which two university staff, instead of the lecturers, came into the classrooms at the 5th minute of the first observed lecture and the 13th minute of the second observed lecture to check students’ cards with the aims of determining who was absent.

On the other hand, in most Australian universities, there is no lecture attendance requirement for students. For that reason, the Australian lecturers did not call the rolls of students and to some extent, the Australian students were allowed to enter or exit the lecture theatres freely when the lectures were in process without asking for the lecturers’ permission. The omission of this process, therefore, could save the time for the lectures.

Regarding the student attendance requirement aspect, it can be argued that the Australian universities tended to encourage students to develop their self-discipline in learning. This is a very important characteristic and it helps students in their learning due to the fact that when they feel interested in learning they are likely to learn more information and knowledge of the disciplines. Moreover, in order to attract students to attend lectures, lecturers also need to spend time and effort to make their lectures and teaching materials more interesting and of high quality. For example, as observed in the lectures, most Australian lecturers employed a variety of teaching approaches and integrated a variety of multimedia tools in their lectures in order to make their lectures more interesting. Therefore, the choice of the Australian universities not calling the roll is part of a general orientation to the purpose of autonomy.

In the Vietnamese universities, students were required to attend classes regularly for over four hours a day from Monday to Friday. Because of the compulsion to attend multiple lectures daily, students seemed to be tired during their lectures as some observed students at the back of classrooms sleeping during lectures. In interviews with
students, some Vietnamese students also said that they felt tired of attending too many lectures a day. For example, one female student from V2 said: “I spend a lot of time for formal studying at the university. I go to class everyday so I feel a bit tired”. The regular attendance mark counted towards the final score of a subject has also been resulted in dishonesty in students. For instance, according to Duyen (2005), instead of going to the classroom to acquire knowledge, some students go to class just to deal the roll call. Students just wait for lecturer finishes calling the roll to sneak out of the classroom. Moreover, to some extent, the compulsory attendance requirement is likely to affect the lecturers’ preparation for their lectures because they might not need to invest too much time and effort to make their lectures interesting in order to attract students to attend lectures.

In the teaching process in lectures, although the Australian lecturers used a variety of ICT approaches in their lectures, the observations showed that teaching and learning approaches in the classrooms were not much different from their Vietnamese counterparts. Principally, teaching approaches that the lecturers used in the physics lectures in both countries were still very much teacher-centred modes in which most of the lecturers presented physics concepts, solved example problems and occasionally gave examples of applications of physics in research and in real life contexts while students listened, took notes, and sometimes raised questions and made comments. Specifically, all eleven physics lectures in the Australian universities and nine lectures in the Vietnamese universities were mainly presented by the lecturers. Table 5.2 shows the time spent by eleven observed lecturers in the Australian universities in their teaching and the time that the students directly involved in each lecture in activities such as raising questions and answering lecturers’ questions. The time duration for activities of the lecturers and the students was counted and recorded minutes by minutes in the observations. The lecturers’ and students’ time duration in minutes is also converted into percentage of total time allowed for each lecture in order to be easy to make the comparison.
Table 5.2: Time spent in the Australian lectures by the lecturers and the students

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Activities</th>
<th>Lecturers</th>
<th></th>
<th>Students</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Time (minutes)</td>
<td>%</td>
<td>Responses</td>
<td>Time (minutes)</td>
</tr>
<tr>
<td>1</td>
<td>- Presenting</td>
<td>28</td>
<td>66.7%</td>
<td>- Answer</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>10</td>
<td>23.8%</td>
<td>- Questions</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>- Presenting</td>
<td>39</td>
<td>65%</td>
<td>- Answer</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>18</td>
<td>30%</td>
<td>- Questions</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>- Presenting</td>
<td>20</td>
<td>44.4%</td>
<td>- Answer</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>20</td>
<td>44.4%</td>
<td>- Questions</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>- Presenting</td>
<td>40</td>
<td>88.9%</td>
<td>- Answer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>5</td>
<td>22.2%</td>
<td>- Questions</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>- Presenting</td>
<td>34</td>
<td>81%</td>
<td>- Answer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>7</td>
<td>16.7%</td>
<td>- Questions</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>- Presenting</td>
<td>19</td>
<td>38%</td>
<td>- Answer</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>25</td>
<td>50%</td>
<td>- Questions</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>- Presenting</td>
<td>25</td>
<td>71.4%</td>
<td>- Answer</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>8</td>
<td>22.9%</td>
<td>- Questions</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>- Presenting</td>
<td>46</td>
<td>92%</td>
<td>- Answer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>4</td>
<td>8%</td>
<td>- Questions</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>- Presenting</td>
<td>37</td>
<td>78.7%</td>
<td>- Answer</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>6</td>
<td>12.8%</td>
<td>- Questions</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>- Presenting</td>
<td>51</td>
<td>92.7%</td>
<td>- Answer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>4</td>
<td>7.3%</td>
<td>- Questions</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>- Presenting</td>
<td>41</td>
<td>91.1%</td>
<td>- Answer</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>- Examples and Questions</td>
<td>4</td>
<td>8.9%</td>
<td>- Questions</td>
<td>0</td>
</tr>
</tbody>
</table>

**Average**: 73.63% 4.93%

It can be seen that on average the total time of the Australian lecturers presenting their materials in the eleven observed undergraduate physics lectures in the Australian universities occupied for 73.63% of the time allowed for each lecture. In comparison, the amount of time that students directly involved in lectures’ activities such as raising questions and answering lecturers’ questions rather than activities of purely listening
taking notes was only 4.93% on average. Therefore, it can be concluded that the lecturers used most of the time of a lecture for their teaching activities. Thus, those lectures were mainly controlled by the lecturers and the main activities in the lectures were lecturers’ presentations of their materials. This kind of one-way communication teaching approach as clarified in Chapter 2 is the teacher-centred mode of teaching.

Similarly, table 5.3 summarises the time used by the Vietnamese physics lecturers and students for their activities in the nine observed lectures.

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Activities</th>
<th>Time (minutes)</th>
<th>%</th>
<th>Responses</th>
<th>Time (minutes)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Presenting</td>
<td>22</td>
<td>48.8%</td>
<td>Answer</td>
<td>7</td>
<td>15.6%</td>
</tr>
<tr>
<td>1</td>
<td>Examples and Questions</td>
<td>16</td>
<td>35.6%</td>
<td>Questions</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>2</td>
<td>Presenting</td>
<td>40</td>
<td>93%</td>
<td>Answer</td>
<td>1</td>
<td>2.4%</td>
</tr>
<tr>
<td>2</td>
<td>Examples and Questions</td>
<td>2</td>
<td>4.65%</td>
<td>Questions</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>Presenting</td>
<td>42</td>
<td>100%</td>
<td>Answer</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>Examples and Questions</td>
<td>0</td>
<td>0%</td>
<td>Questions</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>4</td>
<td>Presenting</td>
<td>43</td>
<td>100%</td>
<td>Answer</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>4</td>
<td>Examples and Questions</td>
<td>0</td>
<td>0%</td>
<td>Questions</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>5</td>
<td>Presenting</td>
<td>38</td>
<td>84.4%</td>
<td>Answer</td>
<td>2</td>
<td>4.45%</td>
</tr>
<tr>
<td>5</td>
<td>Examples and Questions</td>
<td>5</td>
<td>10%</td>
<td>Questions</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>6</td>
<td>Presenting</td>
<td>35</td>
<td>87.5%</td>
<td>Answer</td>
<td>1</td>
<td>2.5%</td>
</tr>
<tr>
<td>6</td>
<td>Examples and Questions</td>
<td>3</td>
<td>7.5%</td>
<td>Questions</td>
<td>1</td>
<td>2.5%</td>
</tr>
<tr>
<td>7</td>
<td>Presenting</td>
<td>33</td>
<td>78.5%</td>
<td>Answer</td>
<td>2</td>
<td>4.76%</td>
</tr>
<tr>
<td>7</td>
<td>Examples and Questions</td>
<td>6</td>
<td>14.3%</td>
<td>Questions</td>
<td>1</td>
<td>2.4%</td>
</tr>
<tr>
<td>8</td>
<td>Presenting</td>
<td>30</td>
<td>71.4%</td>
<td>Answer</td>
<td>3</td>
<td>7.15%</td>
</tr>
<tr>
<td>8</td>
<td>Examples and Questions</td>
<td>7</td>
<td>16.7%</td>
<td>Questions</td>
<td>2</td>
<td>4.8%</td>
</tr>
<tr>
<td>9</td>
<td>Presenting</td>
<td>41</td>
<td>95.3%</td>
<td>Answer</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>9</td>
<td>Examples and Questions</td>
<td>2</td>
<td>4.7%</td>
<td>Questions</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Average 84.3% 5.17%

5 The remaining 21.44% of time allowed for 1 hour lecture in the Australian universities and 10.53% of the time in the Vietnamese universities is used by lecturers to set up lectures.
As can be seen from table 5.3, the kind of teacher-centred mode of teaching in the physics lectures at the Australian universities was also popular in the Vietnamese universities’ undergraduate physics lectures. Particularly, the average time that the Vietnamese lecturers used to present material to students in a lecture accounted for nearly 84.3% of the total time allowed for the lecture. Students spent only 5.17% of the total time allowed on their direct activities in that lecture.

As discussed in literature review chapter, teacher-centred teaching approaches have been criticised by many educational researchers that they are ineffective in helping students develop a more scientific view and conceptual understanding of physics. In this study, most of the studied lecturers in both countries said that they were aware of the disadvantages of this kind of teaching approaches in helping students learn physics effectively. However, many lecturers argued that it was difficult to apply student-centred approaches in their teaching practise because of factors such as the large number of students, not enough funding, and the time constraint. The following example is an extract from an interview with one of the Australian physics education innovators on a question about the nature of lectures:

“... so the intention now if you do not want to run the lectures, you need more people. If instead of one hour lecture you’re going to one hour workshop, you need more people. Instead of having one academic for 200 students, you need one academic for ideally every 20 students or every 40 students. Now nobody can afford that. They can barely cover the lectures. So the problem then becomes how to handle 200 students in one room and not make it teacher-centred”.

(A111)

Although there was a similarity in the lecturers’ teaching approach between the two countries, the significant differences of the lectures observed between the two countries were lecturers’ methods of delivering physics knowledge to students and students’ learning strategies in the lectures. In the Australian universities, most of the observed lectures were integrated with physics animations, simulations, graphics, and diagrams in PowerPoint slides. As a result, in the process of teaching, the lecturers did not spend much time on writing the lessons’ information on boards but they mainly focused on explicating important physics knowledge in the lessons, on explaining meanings of physics constants and variables, and on showing applications of the physics knowledge in real life situations.
Because of having handout notes, Australian students’ main activities in the lectures were listening to the lecturers, looking at their lecture notes and annotating the notes with important points of physics knowledge that they were learning. Moreover, because of the simplicity of the lectures, the amount of physics knowledge delivered in each lecture was not much, which would make it possible for students to remember the main points of the lecture’s physics content. Nonetheless, in order to understand thoroughly and sufficiently the physics knowledge learnt at the lectures required the students to read more physics references and to revise the knowledge at home. This teaching approach to some extent would encourage students to develop self-learning strategies.

On the other hand, the Vietnamese lectures in general were very demanding because the lectures contained a large amount of information. In most of the observed undergraduate physics lectures in the Vietnamese universities, the lecturers presented their materials systematically, following what was inside physics textbooks, and at the same time extensively used chalk to write down the information on boards. Most of the lecturers also spent a lot of time on mathematical manipulations and derivations using complex calculations.

Most of the Vietnamese students concentrated on listening to the lecturers and generally write verbatim all the information that the lecturers were presenting and writing down on the blackboards. As a result, the amount of physics knowledge that students had to absorb for each lecture was a lot more than the amount their Australian peers had to learn. In addition, in all nine undergraduate physics classes that I observed in the Vietnamese universities, students had to sit for at least three consecutive physics lectures among an average of five lectures per day compared to the Australian peers, who had only a one-hour physics lecture in a day. This aspect, concerning the large amount of knowledge for each lecture arguably makes overload the students in the amount of knowledge to learn. Table 5.4 summarises the differences in teaching and learning of undergraduate physics in lectures between the Australian universities and Vietnamese universities.
Table 5.4: Differences in teaching and learning in lectures

<table>
<thead>
<tr>
<th></th>
<th>The Australian universities</th>
<th>The Vietnamese universities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lecturers</strong></td>
<td>Presented main points of physics knowledge</td>
<td>Systematically presented all information;</td>
</tr>
<tr>
<td></td>
<td>Using simulations, animations, graphics, figures in lectures</td>
<td>Drawing some graphics and figures on blackboards</td>
</tr>
<tr>
<td><strong>Students</strong></td>
<td>Annotate notes with important points;</td>
<td>Wrote verbatim almost all information;</td>
</tr>
<tr>
<td><strong>Physics content</strong></td>
<td>Less amount of physics knowledge for each lecture</td>
<td>Large amount of physics knowledge for each lecture and for a day</td>
</tr>
<tr>
<td></td>
<td>Simple mathematical calculations</td>
<td>Required good mathematical skills</td>
</tr>
</tbody>
</table>

The following section describes observed lectures of the same physics subjects and topics in the Australian and the Vietnamese universities to illustrate the differences in physics content knowledge of the lectures between universities in the two countries.

1. Lecture on electromagnetism in Australian A2: attendance of 43 students, lecture theatre 200 seats with computers connected to the Internet, projectors, speakers, prepared demonstration. Lecture started at 11h05’ AM and finished at 11h46’ AM.

11h05’: Lecturer used slides to present Microscopic view of Ohm’s law

\[ \bar{J} = \sigma \bar{E} \]

11h09’: Presented Conductivity and Resistivity

\[ J = \frac{e^2 n_e \tau}{m_e} E \Rightarrow J \sim E \]

11h10’: Presented Resistance

Relationship between R and \( \rho \)

Showed a graph of \( \rho \) versus \( T \)

11h13’: Ohm’s law: \( i = \frac{V}{R} \)

11h14’: Summary

11h15’: Live demonstration: Thermal radiation. Camera showed the hand of meter moving to prove that there was current on the wire when a metal junction was put on a flame.

11h17’: Gases, Metals: slides showed picture of gas and metal junction
Used blackboard to explain there were electrons moving from Cu to Fe (Thermal diffusion, e drift)

Talked and explained about the difference of temperature between two metals: thermal couple

11h27': Direct current circuit: Basic current elements, Batteries and Electromotive force

Lecturer used pictures and diagrams on slides to explain

Lecturer used a picture and diagram of a modern battery used in a car and explained the process of chemical reaction

\[ H_2 \rightarrow 2H^+ + 2e^- \]

11h33': Power in electric circuit

\[ P = \frac{V^2}{R} = i^2 R \]

Lecturer gave an example on the reason of stepping down voltage from 500KV to 240V in houses

11h40': Kirchhoff's rules for circuit

Analysis on Conservation of Charge and Conservation of Energy

Lecturer presented on the convention about the signs of i and \( \xi \) using a diagram

11h43': Resistors in series and in parallel

Lecturer drew diagrams on blackboard to explain

11h46': Finished

2. Lecture on Electromagnetism in Vietnamese V2: attendance of 49 students, lecture room with speakers and a blackboard. Lecture started at 8:30AM and finished at 9:15AM, the same total time as for the Australian lecture.
8h32′: Call the roll of students

8h37′: The nature of electric current: the current of positive charges

Lecturer drew diagrams on blackboard to explain to students electric currents in metals, in electrolysis, and in gases

8h40′: Basic elements of current

\[ I = \frac{dq}{dt} \quad q = \int_0^t dq = \int_0^t Jdt = It; 1C = 1A.1s \]

Current density vector: lecturer drew a picture to explain to students

\[ J = \frac{dI}{dS_n} A/m^2; dI = JdS_n = \vec{J}d\vec{S}; I = \int dI = \int \vec{J}d\vec{S} \]

Current in a cylinder conductor: \( n_0, |e|, \vec{v}, dS_n \)

\[ dn = n_0(\vec{v}dS_n) \]
\[ dI = |e|dn = |e|n_0(\vec{v}dS_n) \]
\[ J = \frac{dI}{dS_n} = n_0|e|\vec{v} \]
\[ \vec{J} = n_0e\vec{v} \]

Current of more than one type of charges:

\[ \vec{J} = \sum_i n_0_i e_i \vec{v}_i \]

8h47′: Ohm’s law for a circuit with only R: drew a diagram on blackboard

\[ I = (V_1 - V_2) / R \]

Conductivity of a circuit: \( \sigma = 1/R \)

Resistor and Resistivity: \( R = \frac{\rho l}{S_n}; \Omega = V / A \)

Dependence of Resistor on Temperature:

\[ R_T = R_0 (1 + \alpha \Delta T); \alpha = \frac{\Delta R}{R \Delta T} \]

Gave an example how to calculate R at different temperatures
8h52': Microscopic view of Ohm’s law: Lecturer drew a picture to show to students

\[ dl = \frac{[V - (V + dV)]}{R} = - \frac{dV}{R} \]

\[ R = \frac{\rho dl}{dS} \]

\[ J = \frac{dl}{dS} = \frac{1}{\rho} \left( - \frac{dV}{dl} \right) \]

\[ J = \sigma E \]

\[ \vec{J} = \sigma \vec{E} \]

8h55': DC circuit

Electromotive force: Lecturer drew a figure of a battery

Power source

‘Strange’ force and ‘strange’ field

Definition of electromotive force

\[ \xi = \frac{A}{q} \]

\[ A = \oint C q (\vec{E} + \vec{E}^*) d\vec{S} \]

\[ \xi - A / q = \oint C \vec{E} d\vec{S} + \oint C \vec{E}^* d\vec{S} \]

\[ \oint C \vec{E} d\vec{S} = 0 \]

9h00: Kirchhoff’s laws: \( \sum_{\text{closed}} \Delta V = \sum_{\text{closed}} \Delta U_i = 0 \)

Lecturer presented on the convention about the signs of \( i \) and \( \xi \) using diagrams

Gave an example for students to calculate electric current

9h10': RC circuit

Lecturer drew a RC circuit on blackboard to explain to students

Used Kirchhoff’s law: \( \xi - IR - \frac{Q}{C} = 0 \)
As can be seen from these two lectures, the Australian lecture focused on main points of the physics knowledge of the lesson. The Australian lecturer did not focus much on the mathematical derivation of the formulae or the multiple constructs such as I, J. There was also a live demonstration at the 15th minute of the lecture following by picture diagrams to show students why there is current running in wires. In the process of teaching, the Australian lecturer also showed how the physics knowledge learnt is related to real life situations by giving the students examples of modern car batteries and household electricity.

The lecture in the Vietnamese university gave students specific details of information of the physics lesson. It involved many mathematical derivations to get to the final formulae. The lecturer concentrated mainly on the mathematical and theoretical aspects of the physics content but not much on application aspects of the knowledge, in real life contexts. Teaching physics that focuses on mathematical aspects of the physics content has created a lot of arguments and debate among Vietnamese physics teachers and lecturers. This kind of teaching approach is endemic not only at higher education levels but also at secondary school levels.

There were similar teaching approaches in another two observed lectures of the same topics in the Australian and Vietnamese universities. For example, in the lecture on Maxwell’s equations, the Vietnamese lecturer focused on mathematical aspects of the physics content of the topic. In the section on the microscopic view of Maxwell-Faraday’s equation, the complex mathematical equations that the students had to learn were:

\[
\begin{align*}
\xi - R \frac{dQ}{dt} - \frac{Q}{C} &= 0 \\
RC \frac{dQ}{C\xi - Q} &= dt \\
Q &= C\xi (1 - e^{-\frac{t}{RC}}) \\
I &= \frac{dQ}{dt} = \frac{\xi}{R} e^{-\frac{t}{RC}}
\end{align*}
\]
\[ \int_{c} E \, dl = \int_{s} \text{rot} E \, dS \]
\[ \int_{c} E \, dl = - \frac{d}{dt} \int_{s} B \, dS \]
\[ \text{rot} E = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix} \]
\[ \int_{s} \text{rot} E \, dS = \int_{s} \left( - \frac{dB}{dt} \right) dS \]
\[ \text{rot} E = - \frac{dB}{dt} \]
\[ \text{rot} E = \vec{i} \left( \frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z} \right) + \vec{j} \left( \frac{\partial E_x}{\partial z} - \frac{\partial E_z}{\partial x} \right) + \vec{k} \left( \frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y} \right) \]

Whereas, the Australian lecturer in the same lecture topic only gave the student the formulae of the main Maxwell’s equations and focused mostly on explaining the meanings of the equations to the students. Teaching physics that does not place much emphasis on mathematical derivations but focuses on meanings of physics and its applications is the common approach to teaching undergraduate physics in the Australian universities. Nevertheless, some of the interviewed lecturers complained about the lack of mathematical and physics background of the students.

The differences in teaching approaches and the knowledge delivered in lecture can be linked to the difference in expectations of graduate students in the two countries. As stated in the Vietnamese education laws, graduate students are expected to possess principled knowledge of chosen disciplines and all the other qualities related to the ideology of building and protecting socialism in Vietnam. The graduate outcomes and expectations in the Australian universities are set out based on the strength of the departments of physics and they are generally focused on the students’ ability to apply knowledge learnt into real life contexts and students’ ability to think critically about the world around them and its mechanism. For example, the following is the objectives of BSc PHY degree in Australian A2:
Physics major will integrate knowledge principally from physics and mathematics to provide students with the necessary tools to think critically about the world around them and how it works. Students should develop a range of theoretical and experimental skills that will allow them to make critical assessments, solve problems, and develop new concepts in a broad range of work environments.

Although the lecturers in the Australian universities did not focus much on mathematical derivation of physics formulae, some of them complained about the poor mathematical and physics background of undergraduate physics students, especially the first year students. One of the lecturers stated that:

“... The students’ background of mathematics and physics is very bad compared to Canada, the United States and Russia... The lack of mathematical knowledge and the level of mathematics taught in Australian high schools and universities is so way behind of what it should be what I’ve seen in Russia and even in Canada...” (A1L1)

The lecturer went on to stress that:

“... I would be extremely disappointed that engineers [students who are studying engineering] in this university have very poor knowledge of basics to become engineers. To access this university, the students need 65% or higher. Engineers are like doctors. Engineers build buildings, bridges and heavy constructions. If an engineer has an average mark of 65%, it means that 35% he or she doesn’t know. It is absolutely a disaster for society”.

In summary, the observations of classroom teaching of undergraduate physics in the studied universities in both countries show that the lecturers’ teaching approaches in both countries were much the same, as both countries’ lecturers employed teacher-centred methods, in which an average of more than 73.63% and 84.3% of the time for a 1-hour lecture was used by the lecturers in the Australian universities and Vietnamese universities respectively. Nonetheless, the Australian lecturers employed the availability of modern and well-equipped teaching and learning facilities such as computers, the Internet, lecture notes, and demonstration equipment to make their lectures more interesting and understandable to the students. The physics lectures in the Australian universities also focused much on application aspects of particular physics knowledge to real world situations and less on mathematical derivations of physics formulae. On the other hand, the lectures in the Vietnamese universities were mainly “read and write” methods of teaching, in which the lecturers presented the information using chalk and
talk while students were listening and taking notes. In addition, to some extent, the
Vietnamese lectures usually delivered large amount of physics knowledge with difficult
mathematical derivations and lack of information on the application aspects of the
knowledge, compared to their Australian counterparts.

5.3. Observation of teaching and learning in tutorials

Tutorials are one of the important components in teaching physics subjects
because tutorials give students the opportunity to go over course content conveyed
during lectures and help students develop a functional understanding of physics
concepts. In this study, nine physics tutorials in the Australian universities and nine
physics tutorials in the Vietnamese universities were observed. The observation was in-
class non-participant type and each observation lasted for one hour. The rationale of the
comparative observation of tutorial activities is to discover how undergraduate physics
tutorials were run in the Australian and the Vietnamese universities with the aims of
finding out differences and similarities in tutorial sessions between the universities in the
two countries and identifying key features in delivering the tutorials.

5.3.1. Tutorial venues

Most of the tutorials for undergraduate physics students in the Australian
universities were run using small groups of students. The average number of students for
each tutorial session was 13 students. The six observed first year tutorials in the A2 and
A3 in Australia were in the tutorial rooms which were designed solely for tutorial
sessions with several multilayer blackboards for each room. Tables and chairs in these
tutorial venues were arranged in a way that aims to promote and encourage group
discussions. All the six tutorials in the A2 and A3 were run by tutors who were in third
year undergraduate students, honours degree and research students at the universities.
Among observed tutorials, there were three tutorials in the Australian A1 which were
incorporated online tutorials and quizzes. In these three tutorials, students solved physics
problems on learning resources online via the Learning Management System (LMS),
where all physics lecture, laboratory and problem class materials were available to the
undergraduate physics students.
In Vietnam, all the nine observed tutorials were in normal classrooms, which were also used for the lectures as described in the previous section. In these normal classrooms, there was only one blackboard for each room and tables and benches were arranged in fixed traditional rows. The tutorials in the three observed universities in Vietnam were run by the same lecturers of the physics disciplines that they taught. For each subject, all of the students attending lectures were required to participate in the tutorials at the same time. Therefore, the number of students attending tutorial sessions was as the same number of students attending lectures. As a result, there were a large number of students in a tutorial in the Vietnamese universities compared to the number of students in a tutorial in the Australian universities where they provided several tutorial sessions for each set of problems. Table 5.5 shows the preparations of typical tutorials in the Australian universities and the Vietnamese universities.

<table>
<thead>
<tr>
<th>The Australian universities</th>
<th>The Vietnamese universities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial rooms with several multi-layer boards, flexible setting of tables and chairs</td>
<td>Normal classrooms with one board, fixed setting of tables and benches</td>
</tr>
<tr>
<td>Small groups of about 13 students</td>
<td>Whole class tutorial of over 50 students</td>
</tr>
<tr>
<td>Students sitting in groups</td>
<td>Students sitting in rows as in the lectures</td>
</tr>
<tr>
<td>Run by tutors</td>
<td>Run by lecturers</td>
</tr>
</tbody>
</table>

5.3.2. **Teaching and learning approaches in tutorials**

All six tutorials in the Australian A2 and A3 were small group tutorials with an average of thirteen students attending each tutorial. At the beginning of the tutorials, the tutors usually asked the students to form groups of three to four students. The tutors then revised and summarised physics knowledge necessary for the tutorials. In all of these six tutorials, the tutors explained and solved the problems on blackboards. In the process of solving the problems, the tutors frequently asked the students questions about physics knowledge related to the problems solved. After the tutors finished a problem, they went to each group to explain to them what they had not understood. Another approach in the tutorials was the tutors asked students to discuss physics problems in their groups. The tutors then went to each group to explain and help the students solve the problems.
Most of the students at these tutorial classes concentrated on the tutors’ instructions and solutions. Almost all of the observed students took notes of the solutions that the tutors solved on the blackboards. At some points in the tutorials when the tutors asked the students to look at the problems, there were discussions among individuals in each group. The students also asked the tutors many questions when they did not understand the physics knowledge and the problems being solved. This kind of small group tutorial encourages interaction between students and students and between students and the tutors.

The following is an example of activities of a tutor and students in an observed tutorial in the Australian A2. The topic of the tutorial was longitudinal and transverse waves and it is conducted by the tutor who was a third year student at the department of physics. It lasted for one hour and had an attendance of fifteen students divided into five groups.

12h00’:
- Tutor wrote down on blackboard the definition of longitudinal and transverse waves;
- Students observed and took notes;
- The tutor drew graphs of waves to explain carefully to the students about travelling of waves and the wave function: \( y(x) = A\sin\left(\frac{2\pi}{\lambda} x\right) \) and revised the knowledge that the students had learnt at their lectures.

12h20’:
- The tutor wrote down a wave function: \( y(x,t) = A\sin\left(\frac{2\pi}{\lambda} x + \frac{2\pi}{T} t + \phi_0\right) \) and asked the students whether they had any question about the meanings of this wave equation.
- The tutor explained in answer to the question from a student asking about meanings of the equation’s components.

12h28’:
- The tutor asked the students to look at Question 2 and then had discussions among individuals in groups.
- The tutor went around to each group to explain the problem to them.

12h36’:
- After explaining to each group, the tutor moved on to draw graphs on the blackboard, explained and made a conclusion.

12h40’:
- The tutor drew and explained to the students about Interference
- The tutor asked the students to look at Question 1
- The students discussed in groups and asked the tutor questions

12h55’:
The tutor answered the students’ questions and solved the problems by asking the students questions in the process of problem solving.

Three tutorials in the Australian A1 were online tutorials, tests and quizzes downloaded via the department of physics website, in which students solve problems online. For each tutorial session, there were a lecturer and three tutors to instruct and help students solve the online problems. The average number of students attending these online tutorials was thirty six students divided into groups of three to four students. Each group of students shared one computer to solve the problems together. This kind of tutorial encouraged interactions between individuals among each group, among groups, and with the lecturer and tutors. Particularly, at the beginning of each tutorial, lecturer and tutors went to each group to explain and discuss with students. The students in each group then discussed and solved problems together. In the process of solving problems, students moved around to other groups to ask questions and if the problem could not be solved, they asked the lecturer and the tutors.

The following is an example of the interactions among individuals and groups in online tutorials at the A1 in Australia.

11h00’:
- Students logged onto computers to open problems. There were hints in each problem question. Students could open lecture notes and problems on the same screen.
- Lecturer moved to each group to discuss with students

11h15’:
- Lecturer explained to students about ‘buoyancy force’ and asked and solved the problem ‘How much does a volume (cubic meter) of salt water weigh?’

11h23’:
- One student voluntarily came to the blackboard to solve the problems while other students discussed in groups.

11h25’:
- The lecturer explained more to students about the problem. Some students raised their hands to ask questions. Other students went to different groups to discuss. Tutors came to explain and help them.

11h31’:
- The lecturer asked one group of students to come to solve the problem at the blackboard. One student in the group directly solved the problem while other members of the group observed and helped him.
- Other groups worked on their own with the help of the tutors

11h45’:
- The lecturer asked who did not understand problem 3 to come to the blackboard. There were nine students came to the blackboard and stood
around the lecturer. The lecturer explained and instructed the students on how to solve it.
- The remaining students worked in groups with the help of tutors.

12h00': Finished

As can be seen from two examples above that the Australian tutorials were usually taught in small groups. The lecturers and tutors tried to promote and encourage interactions among students and between students and the instructors. The tutorials did not focus on mathematical manipulations but instructed students how to apply physics knowledge learnt in lectures in order to solve problems. Moreover, the students did not have much pressure of completing the homework prior to the tutorials because one of the aims of tutorials is to help student solve physics problems in order to revise and strengthen the knowledge they learn in lectures.

In the Vietnamese way of learning, students are usually given homework after each lecture and they are required to solve it on their homework notebooks and bring the notes to the following tutorial session. Generally, in the observed universities in Vietnam, at the beginning of all the observed physics tutorials, the lecturers called the rolls of all students and then named three to four students to come up to blackboards to solve problems that were determined by the lecturers. While these students solved the problems, the lecturers marked the homework done in their homework notebooks. When students finished doing the problems given, the lecturers asked all other students to correct them. The lecturers then explained more and corrected difficult problems. The lecturers then used the students’ homework notebooks and the problems that they solved on the blackboard as the basis to give final marks to the students. The marks were announced to the whole class.

For each tutorial session that lasted for forty five minutes, there were an average of about six students who had to come up to solve homework problems in front of the whole class. These students usually were required to remember how to solve the problems by themselves because they normally were not allowed to look at their homework notebooks, in order to prevent from copying from each other. However, in two observed tutorials in the V3, the students were allowed to look at their homework notebooks when they were solving the problems on the blackboard. The remaining
students who had not finished their homework continued doing the problems while others who had done them at home observed the students solving at the blackboard.

The following is a typical example of the observed tutorials in the Vietnamese universities, which may represent the way the tutorials in the Vietnamese universities were taught because most observed tutorials had similar teaching and learning process. This tutorial lasted for forty-five minutes and there was an attendance of 46 students under the guidance of their lecturer.

10h15':
- The lecturer called the roll of students.
- The lecturer named three students from the roll and asked them to come to blackboard to solve problems numbered 1.3, 1.4, and 1.5 in the text book.

10h20':
- Three students divided the blackboard into three columns and started solving the problems.
- The lecturer looked at their homework notebooks.
- Other remaining students concentrated on doing their homework.

10h28':
- The student working on problem 1.4 finished and went back to his seat.
- Lecturer told other students to look at the solution and give comments.
- Lecturer explained more about the problem and the solution.
- Lecturer gave the student 8 marks out of 10.
- Lecturer named another student to come to solve problem 1.7.

10h35':
- Two students also finished their problems and came back to their seats.
- One student put his hand up to give comments on problem 1.3.
- Lecturer made amendments to the problem. The lecturer gave the student 6 marks out of 10.
- The lecturer congratulated the student doing problem 1.5 and gave her 9 marks out of ten.

10h42':
- Lecturer called two other students to come to solve problems 1.9 and 1.10.
- The student doing problem 1.7 was struggling with his solution to the problem.
- Lecturer asked and instructed him how to solve it. Lecturer revised and reminded him and all the class about some physics knowledge.

11h00': Finished

This observed tutorial is typical of tutorials in the Vietnamese universities. This approach of tutorials is also popular for most of subjects in primary and secondary schools in Vietnam. Students must complete all of the homework problems prior to tutorial session if they do not want to get bad marks and lose their face in front of all the class. Penalties such as standing at the blackboard in front of whole class for a period of
time or writing their names into a ‘regularly observed book’ are still popular at all Vietnamese educational levels, especially at primary and secondary school levels. This teaching approach in tutorial sessions makes students work hard at home in order to complete all the problems. However, at the same time, it also creates a lot of pressure on students, which is likely to be one of the reasons driving dishonest behaviour and plagiarism. According to Bach (2012), copy and paste in essays and assignments is becoming an incurable disease of the Vietnamese education, especially at higher levels of the education system.

To summarise, the tutorial in the Australian universities is designed to offer instruction in order to help students solve physics problems and understand physics knowledge lying behind formulae and numbers. Students come to tutorial sessions to learn and to exchange ideas with other students and tutors without any pressure or strains. Whereas, the tutorial in the Vietnamese universities operate as a kind of examining or checking of students’ ability as well as their diligence in doing their homework problems. Some students expressed in the interviews that they sometimes felt the pressure and unpleasant emotion of going to tutorials where they could be publicly exposed in front of the whole class, especially when they had not completed all of the homework problems. While the core function is to help students learn to solve problems in each case, the organisation of students’ work, the role of the tutor and lecturer and the presumptions about learning, are very different in the two countries.

5.4. Observations of laboratory activities

Laboratory work is essential, and in theory indispensable in learning physics. According to Lijnse (1998, p. 4), “physics is an empirical science, it is considered an inherent part of physics to learn about nature by finding out, hypothesising, testing and experimenting for yourself, i.e. students should be learning physics by doing physics”. In the Australian and in the Vietnamese universities, learning physics in laboratories is a compulsory part of the course. This laboratory observation aims at identifying similar and different features of undergraduate physics laboratory teaching and learning in the universities in the two countries. There were nine laboratory observations in the

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6 Each class from primary school to higher education level has a ‘regularly observed book’ for teachers to write down all special information happening in their lectures at the class and to grade students’ preparations as well as their attitude in the lectures.
Australian universities and nine observations in the Vietnamese universities. All of the observations were non participant types.

Besides introducing students to important techniques of experimental physics in order to develop students’ practical skills, the experiments in most of the Australian universities also aim at strengthening the physics theories and concepts that the students learn in lectures. For example, the first year laboratory experiments in Australian university A2 include the following modules:

- **Optics**: Optics 1 – Thin Films; Optics 2 – Thin Lenses; and Optics 3 – Polarisation of Light.

- **Waves**: Waves/Rotation 1 – Vibrations in an Air Column; Waves/Rotation 2 – Rotational Motion.

- **Mechanics**: Mechanics 1 – Linear Motion and Newton’s Laws; Mechanics 2 – Relativity and Particle Physics; Mechanics 3 – Simple Harmonic Motion.

These experiments’ content is a part of the first year curriculum and syllabi of the physics course and it is covered in lectures. Hence, particular knowledge that the students learn in lectures is circulated in tutorials and then in laboratories. As indicated by the A2, lectures, tutorials and laboratory work are intertwined in such a way that “lectures will improve your understand of labs, and labs will improve your understand of lectures”. This kind of teaching is designed to help students to strengthen their understanding of the knowledge because the students are able to revise the knowledge in different learning contexts.

As described in section 5.1, the laboratories in the Australian universities are organised as research centres for students. All of the laboratories were equipped with computers and printers. Physics books, references, laboratory manuals, and the Internet were available for students to look up necessary physics knowledge. Laboratory demonstrators in the Australian universities were mainly research students at the departments of physics. For each three-hour experiment session, there was an average of two demonstrators instructing six groups of two students.
The experiments observed in first year were from different fields such as optics, waves and rotation, and mechanics. These experiments were set up prior to the session by laboratory staff and there were five out of nine experiments that were directly connected to computers to manipulate data. All of the three observed universities in Australia required students to do pre-lab exercises prior to the experiment sessions. These exercises aimed to help students become familiar with the apparatus of each experiment and to make them understand experimental methods used in the experiment. For example, in A2, students had to read through the laboratory manual for the experiment and then complete on-line questions before performing it. A pre-lab exercise usually comprised 20% of the total mark for a particular experiment.

At the beginning of an experiment, demonstrators always showed students how to perform the experiment safely in accordance with laboratory rules and safe work procedures. Demonstrators then went on to instruct students in the correct use of laboratory apparatuses and assisted students in understanding the physics concepts involved in each experiment as well as the methods of performing it. In the process of students performing their experiments, demonstrators spent time moving around the laboratories answering students’ questions and queries and instructing students in the right methods and procedures for their performances.

In all of the observed experiments, each student was allowed to pick a partner to form a group of two students. Nevertheless, most of the physics departments encouraged students to change their group partners for different laboratory sessions in order to develop students’ skills in working with many people. For each three-hour laboratory session, there were about six groups of students performing six different experiments. Most students concentrated on doing their own experiments. In the process of performing the experiment in each group, students worked in close collaboration with each other and there were frequent interactions with their demonstrators. Students had basic computer knowledge in using Microsoft Word and Excel to manipulate data and graphs. Students kept their experimental records which included methods and aims of experiments, data, results, and reports, in their logbooks. Although students usually worked in pairs, the logbook of an individual student was the individual’s own record because the departments and the universities were very strict with plagiarism.
Likewise, teaching and learning activities in undergraduate physics laboratories in the observed Vietnamese universities were largely the same as in the Australian universities. However, there were nevertheless some noticeable differences. As described in section 5.1, the laboratories and their equipment and apparatus in the Vietnamese universities were not adequately resourced. Most of the first year laboratories did not have computers, the Internet, printers, or physics book and references.

The average number of students in each group was four students compared to two students in the Australian universities. There was an average of two demonstrators for every six groups of four students. At the beginning of the experimental session, in most of the Vietnamese universities, demonstrators checked students’ preparation of the experiments that they were going to perform. The demonstrators then had short oral tests with individual students about related issues and problems of the experiments. If students did not prepare well enough in knowledge of the experiments they would not be allowed to perform the experiments. The oral tests on the students made them seem quite nervous and they seemed quite anxious about going into the laboratory.

An average of four students performed each experiment in a limited room space in the laboratories. This resulted in uneven workload for each individual in the group. Particularly, as I observed in a number of cases, there were several students who did not actively collaborate with others and these students relied mainly on the work of active member in their groups. Nevertheless, there were still lots of interactions among students in most groups and between demonstrators and the students.

Another noticeable difference in learning activities in laboratories was the manipulation of data and reports. Particularly, as observed in some cases, laboratory reports of the Vietnamese students had multiple mathematical derivations involved high level of mathematical knowledge. The laboratory reports in the Vietnamese universities are usually printed as the same format for different experiments, which includes Part 1 – aims of the experiment, Part 2 – the data and result of the experiment, Part 3 – calculate and manipulate the data. All of the data collected was manually calculated and students were allowed to write their experimental reports at home.
In summary, teaching and learning in undergraduate physics laboratories at the Australian and the Vietnamese universities is not much different because activities in physics laboratory are quite standard internationally. Nonetheless, there were still some noticeable differences in the way the students performed in the laboratories. Firstly, teaching and learning conditions in the Australian universities’ laboratories were more adequate than in the Vietnamese universities. Most undergraduate physics laboratories in the Australian universities were spacious and well equipped with modern facilities, good experimental instruments and the availability of ICTs compared to the laboratories in the Vietnamese universities.

Secondly, the average number of students performing a specific experiment in the Australian universities was two students compared to an average of four students in Vietnam. The fewer number of students doing an experiment makes it more likely that individual members of the group will be actively involved in performing and learning. In contrast, the greater number of students doing the same experiment in a limited area of the room sometimes resulted in some individual students not being involved in the process of discussing and manipulating the apparatus.

Finally, the pre-lab exercises and writing laboratory report requirements in the Vietnamese universities was also different from the Australian requirements. While the Australian students did pre-lab exercises online prior to laboratory sessions, the Vietnamese students had to take oral tests at the beginning of an experiment. The Australian students’ experimental reports required students to interpret the data, discuss the results, and made conclusions of what they had done on the laboratory while the Vietnamese students followed the available experimental forms to fill the data number in to calculate the experimental results. Moreover, plagiarism is considered one of serious offences in the Australian universities so that the report is an individual one while the Vietnamese universities allowed the students to complete their reports at home.

5.5. **Chapter summary**

This chapter has described the observations of teaching and learning activities in undergraduate physics lectures, tutorials and laboratory sessions in the Australian and the Vietnamese universities. The observations show that the teaching and learning
facilities and equipment for undergraduate physics at the departments of physics in the Australian universities are superior to those in Vietnam. The better infrastructure has a significant impact on the teaching and learning experience in the classrooms and the laboratories of the Australian undergraduate physics. Particularly, the Australian students had opportunities to experience various teaching approaches that the lecturers employed the availability of teaching and learning facilities in the departments and schools in order to make their lectures more interesting and comprehensible to the learners. The availability of ICTs and their services also gave the students opportunities to access learning materials and supports beyond classroom settings. Whereas, all of the observed Vietnamese lectures were a kind of ‘chalk and talk’ teaching approach, where the main activities of the students were listening to the presenters and copying words and blackboards’ notes.

Although, pedagogically, teaching approaches in lectures in both countries were very much teacher-centred modes where the lecturers used most of the lecture time to present their materials, the process of delivering curriculum content to the students in the universities in the two countries was different. Particularly, as observed in the lectures, the Australian lectures focused on important points of the knowledge and tried to avoid details and difficult mathematical derivations and manipulations. They also encouraged the students in understanding the meaning of physics lying behind physics laws, principles and numbers and in applying the knowledge into real world contexts. On the other hand, most of the Vietnamese lectures covered teaching knowledge in details with multiple mathematical expressions. Arguably, the large amount of knowledge and the teaching of physics that focused on mathematical manipulations are more likely drive the students into memorisation of the knowledge learnt but not on the conceptual understanding of physics.

Likewise, in tutorial sessions, the Australian tutorials aimed to help the students to revise and strengthen the knowledge learnt in the lectures, to improve problem solving skills in students, and to promote students’ collaborative working attitudes by studying in small groups with the help of tutors. While in the Vietnamese tutorials, the students were exposed to the whole class in order to prove themselves that they worked
hard in learning and they had ability to solve the problems by solving their homework in front of other students.

Teaching and learning activities in undergraduate physics laboratories in the Australian and the Vietnamese universities shared similar features regarding the standard procedure of performing a physics experiment. However, because of having better facilities, experimental instruments, and especially ICTs, the laboratories in the Australian universities were more authentic in use of technology and calculation, with more reporting freedom and more collaboration in writing reports. In contrast, the students in the Vietnamese laboratories seemed to follow a traditional cook-book procedure in collecting data and writing reports when they were given experimental report forms to fill in the information. In addition, a large number of students performing an experiment resulted in redundancies in some of the members of the group because some individual students seemed to rely on others’ work. Besides, given students were able to take the reports home, collaboration conclusions might have occurred outside the laboratories.

The requirements and the teaching approaches in lectures, tutorials and laboratories in the Vietnamese universities is likely to require the students to work harder than their Australian peers in order to meet the universities’ expectation. However, achieving competence at interpreting and applying theory will not be helpful for careers after graduation if there is a lack of knowledge of practical application, problem solving skills and ability to think clearly. This kind of training students in higher education institutions in Vietnam has long been criticised by many educators and entrepreneurs, in which according to Anh (2011), 94% of graduate students have to be retrained to be able to work despite of having good knowledge of their fields.
Chapter 6. Students’ Perspectives on Undergraduate Physics Teaching and Learning Practices

Chapter 4 and Chapter 5 described the conditions and actual practices of undergraduate physics teaching and learning in the Australian universities and the Vietnamese universities. This chapter will investigate how students in these universities perceive the undergraduate physics teaching and learning practices at their universities. It will investigate students’ views about: issues that challenge their learning of physics and how they deal with these challenges; features of undergraduate physics teaching and learning practices that help them in learning physics; effective learning strategies and methods; learning resources; and physics courses. The students’ perspectives on teaching and learning practices are disclosed by using questionnaires and interviews. The questionnaire includes two parts – Part 1 is about the demographic of the students and Part 2 aims to explore students’ learning experience at the departments of physics and at their universities. All the data collected from the questionnaire was analysed by grouping into themes and categories before it was colour coded using Microsoft Excel Software in order to make it easy for interpretation. The data from interviews were transcribed into English and grouped into themes and categories. There were 89 Australian students and 147 Vietnamese students filling the questionnaires and there were also eight in-depth interviews with Australian student groups and individuals and nine in-depth interviews with student groups and individuals in the Vietnamese universities.

6.1. The demographic of students participating in study

There were 89 students from three Australian universities participating in this study, in which there were 58 male students (65.9%), 30 female students (34.1%), and 1 student did not response to the question. All of the students were full time students at schools of science and departments of physics at these studied universities and most of them were studying for a Bachelor of Science degree in physics and engineering, 5 students were studying for a Bachelor degree in biomedicine, and 14 students studied for double degrees. There were 52 first year students (58.4%), 18 second year students (20.2%), 5 third year students (5.6%), and 14 fourth year students (15.7%).
There were 147 students from three Vietnamese universities who filled in questionnaires, of which there were 53 male students and 94 female students – 36% and 64% respectively. All of the students were full time students at departments of physics at these studied universities and most of them were studying for Bachelor of Science degree in physics and engineering and 34 students were studying for Bachelor degree in physics education. There were 10 first year students (6.9%), 100 second year students (69%), 5 third year students (3.4%), 20 fourth year students (20.7%), and 2 students did not answer the question.

In order to check the validity of the questionnaire and to have more insights into how the students think about the teaching and learning at their universities and departments, there were in-depth interviews with focus groups of students and with individual students. Some of the students who participated in the interviews were also among those who filled in the questionnaire. There were eight interviews with groups and individual students in the Australian universities and nine interviews in the Vietnamese universities. Each interview lasted for about 15 minutes. The interviews with students in the Australian universities were recorded using a digital note taker while the interviews in the Vietnamese universities were recorded in notes because most of the Vietnamese students requested to keep their identities anonymous.

6.2. Students’ opinions on physics

This section will discover students’ opinions on their experiences in learning physics. It aims to reveal similarities and differences between the Australian students and the Vietnamese students in reasons of learning physics, obstacles in process of learning and how the students overcome those difficulties to learn physics effectively.

6.2.1. Students’ reasons of choosing to study physics subjects

Most students in both countries gave several reasons to the open question “Why did you choose to study physics?” and they were categorised into the following themes: “physics has many applications in technologies and in real life”, “I like physics or physics is interesting”, “I chose to study physics because I like to be... in future”, “I chose physics because of my parents’ wishes”, “I studied physics because of my
course’s requirement”, and “physics is an easy subject”. Figure 6.1 shows the students’ reasons of learning physics in Australia and in Vietnam.

![Figure 6.1: Students’ reasons of choosing to study physics](image)

From Figure 6.1, most of the students in both countries chose to study physics because they liked physics and considered physics as an interesting subject with more than 50% of surveyed students in both the Vietnamese and Australian universities rated this category. It is interesting that there were more Vietnamese students who valued the application aspects of physics than their Australian peers. Particularly, there were 38% Vietnamese students stating that they studied physics because physics had many applications in technologies and in real life compared to 17.2% for the Australian students. Another significant difference in the reasons of choosing to enrol in physics courses is the requirements of the degree. 34.5% Australian students studied physics because of their courses’ requirement. These students could enrol in courses such as biomedicine, nanotechnologies, and engineering, in which physics was a compulsory component of the course while none of Vietnamese students stated this. Interestingly, 3.5% Vietnamese students chose to study physics in order to satisfy their parents’ wishes because in Vietnamese tradition, parents’ guidance and wishes have a very strong impact on their children’s future. Another interesting feature from the students’ responses is that most of the students in both countries did not value much the influence of their careers in choosing to study physics with around 10% of the students in each country mentioned
it. Finally, most of the students in both countries considered physics as a difficult subject to learn. Particularly, there were only 1 Australian student (1.1%) and 5 Vietnamese students (3.5%) who stated that physics is easier than other subjects.

As can be seen from the data above that the reasons of choosing to study physics of the students in both countries shared some common aspects. Particularly, both countries’ students liked to learn physics because physics is an interesting subject and physics has many applications in technology and everyday lives. The students in both countries also considered physics as a difficult subject to learn. Yet there is a slight difference that some students in the Vietnamese universities chose to study physics to satisfy their parents’ expectation.

6.2.2. Challenges faced by students in their physics learning

Seven possible reasons were suggested as to what issues that challenge students in their physics learning. The students were to make their choices from the four possible options provided and open spaces after each issue to let them state their approaches to tackle the issues. Table 6.1 shows the issues that challenged student learning of physics in Vietnam and the weighted mean for each item.

<table>
<thead>
<tr>
<th>Issues</th>
<th>VS</th>
<th>S</th>
<th>LS</th>
<th>NS</th>
<th>RC</th>
<th>WM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of mathematical skills</td>
<td>14</td>
<td>51</td>
<td>59</td>
<td>22</td>
<td>146</td>
<td>1.4</td>
</tr>
<tr>
<td>Lack of physics background</td>
<td>5</td>
<td>28</td>
<td>53</td>
<td>59</td>
<td>145</td>
<td>0.9</td>
</tr>
<tr>
<td>Lack of practical skills</td>
<td>29</td>
<td>71</td>
<td>36</td>
<td>10</td>
<td>146</td>
<td>1.8</td>
</tr>
<tr>
<td>Lack of engagement and motivation in studying</td>
<td>8</td>
<td>21</td>
<td>50</td>
<td>66</td>
<td>145</td>
<td>0.8</td>
</tr>
<tr>
<td>Difficulty of the subject</td>
<td>19</td>
<td>64</td>
<td>43</td>
<td>20</td>
<td>146</td>
<td>1.6</td>
</tr>
<tr>
<td>Lack of problem solving skills</td>
<td>17</td>
<td>75</td>
<td>38</td>
<td>15</td>
<td>145</td>
<td>1.6</td>
</tr>
<tr>
<td>Lack of learning resources and facilities</td>
<td>11</td>
<td>52</td>
<td>42</td>
<td>33</td>
<td>138</td>
<td>1.3</td>
</tr>
</tbody>
</table>

From Table 6.1, the order of the highest to lowest weighted means of issues that challenged the Vietnamese students in their physics learning is as follows:

1. Lack of practical skills
2. Lack of problem solving skills
3. Difficulty of the subject
4. Lack of mathematical skills
5. Lack of learning resources and facilities
6. Lack of physics background
7. Lack of engagement and motivation in studying

Table 6.2 shows the issues that challenged student learning of physics in Australia and the weighted mean for each item.

Table 6.2: Issues that challenge student learning of physics in Australia

<table>
<thead>
<tr>
<th>Issues</th>
<th>VS</th>
<th>S</th>
<th>LS</th>
<th>NS</th>
<th>RC</th>
<th>WM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of mathematical skills</td>
<td>12</td>
<td>20</td>
<td>36</td>
<td>21</td>
<td>89</td>
<td>1.3</td>
</tr>
<tr>
<td>Lack of physics background</td>
<td>12</td>
<td>20</td>
<td>25</td>
<td>32</td>
<td>89</td>
<td>1.1</td>
</tr>
<tr>
<td>Lack of practical skills</td>
<td>6</td>
<td>18</td>
<td>38</td>
<td>27</td>
<td>89</td>
<td>1.0</td>
</tr>
<tr>
<td>Lack of engagement and motivation in studying</td>
<td>21</td>
<td>22</td>
<td>28</td>
<td>17</td>
<td>88</td>
<td>1.5</td>
</tr>
<tr>
<td>Difficulty of the subject</td>
<td>9</td>
<td>44</td>
<td>31</td>
<td>4</td>
<td>88</td>
<td>1.7</td>
</tr>
<tr>
<td>Lack of problem solving skills</td>
<td>8</td>
<td>22</td>
<td>37</td>
<td>22</td>
<td>89</td>
<td>1.2</td>
</tr>
<tr>
<td>Lack of learning resources and facilities</td>
<td>6</td>
<td>13</td>
<td>23</td>
<td>45</td>
<td>87</td>
<td>0.8</td>
</tr>
</tbody>
</table>


From this table, the order of the weighted mean of issues that challenged the Australian students in their physics learning is as follows:

1. Difficulty of the subject
2. Lack of engagement and motivation in studying
3. Lack of mathematical skills
4. Lack of problem solving skills
5. Lack of physics background
6. Lack of practical skills
7. Lack of learning resources and facilities

Based on the students’ responses to the question in the Australian and the Vietnamese universities and the weighted means calculated from the number of responses to the categories, Figure 6.2 on students’ responses to the challenging issues
that affect their physics learning is constructed in order to make comparison between two countries.

![Figure 6.2: Students’ responses to challenging issues with their physics learning](image)

From the student responses and from Figure 6.2, it can be seen that the most challenging issue to Vietnamese students in their physics learning was the lack of practical skills and following by the lack of problem solving skills. As described in Chapter 5, the observation on teaching and learning activities in the tutorial sessions and in the laboratories revealed that the Vietnamese students in most observed universities followed a same format of learning and instruction, which probably deadened students’ creativity. The teaching and learning approaches in laboratories and especially in tutorials in the Vietnamese universities were most likely to drive students into memorising the knowledge learnt but not on gaining necessary skills such as practical and problem solving skills. As a result, the students found it difficult to master these skills that are essentially necessary for their future careers as engineers or technicians.

The Vietnamese students seemed not to have much problem with the engagement and motivation and background physics knowledge in their process of learning physics. Vietnamese students in general are very studious and usually required to work hard in
their learning. They are usually pushed hard by their parents through learning with the hope that they would have bright futures. For example, students as young as kindergarten are put in extra private courses. The extra private classes have been a debatable topic in Vietnamese education forums and conferences for many years and have been considered by many educators as “educational disease” (Nguyen, 2011). In addition, as described in Chapter 4, compared to the Australian students, the Vietnamese students had to study more physics content and more mathematics in secondary school levels than their Australian peers.

In contrast, the Australian students considered the difficulty of physics subjects and the lack of motivation and engagement as the most challenging factors in learning physics while learning resources and practical skills seemed not too much challenging issues to their physics study. The students’ opinions might reflect the way that physics in general and other physical science subjects such as chemistry or biology are delivered in Australian lower education levels. Particularly, some of the students were learning physics and engineering courses with only one year of concentration of learning physics at secondary school levels. The lack of physics background required students to have their commitments to learning in order to understand difficult physics concepts.

The students in both countries considered that the lack of mathematical skills also affected them in effectively learning physics subjects. Obviously, physics has long been considered as a difficult subject that requires learners to have good mathematical knowledge and mathematically derivative skills. As observed in lectures and in tutorials, the Australian lecturers did not focus much on mathematical aspects of physics knowledge but on conceptual understanding and applications of physics knowledge. This approach in physics teaching helped students learn physics in a meaningful way but at the same time, students also found it difficult to understand advanced physics topics which required high level of mathematics such as electromagnetism, quantum physics, etc.

Finally, the number of the students stating that the lack of or the inadequacy of teaching and learning resources in the Vietnamese universities were higher than in the Australian universities. As described in chapter 4, the Australian infrastructure, facilities and resources for undergraduate physics in particular and for other areas in general are
much better than those of the Vietnamese universities. Nevertheless, the Vietnamese
government has invested heavily on teaching and learning infrastructure, facilities,
equipment and resources for over decades. The investment has improved the teaching
and learning conditions at almost all educational levels in Vietnam for recent years and
has shortened the gap in compared with universities in developed countries.

6.2.3. Students’ learning strategies and methods to tackle the challenges

To get information on how the students deal with those issues, opened space after
each issue was designed in the questionnaire for the students to respond. The results of
the students’ responses to open-ended questions on their approaches to tackle the
challenging issues that affected them in studying physics effectively were quite
scattered. However, the responses from the students in both countries were quite similar.
The following responses were the most frequent answers from the students in the two
countries on how to tackle the issues that they considered challenging factor in their
learning of physics.

- For lack of mathematical skills: *I need to revise basic knowledge of maths; I
  need to learn more maths for physics; and I need to practice to solve a lot of
  physics problems in order to master maths knowledge.*

- For the lack of physics background: *I try to learn from simple physics
  knowledge gradually to more difficult ones; I read more physics textbooks
  and references and do more homework problems; I revise forgotten physics
  knowledge by reading secondary school physics textbooks and references.*

- For the lack of practical skills: *I need to do more practical work; I need to be
  actively involved in doing practical work.*

- For the lack of engagement and motivation in studying: *I try to create
  motivation and look at positive aspects; Lecturers should create students’
  motivation; I try learning motivation through lectures.*

- For the difficulty of the subject: *I try to learn physics from different
  references and resources; I try to learn physics as much time as possible. I
  try to get help from peers and lecturers when I do not understand something.*
- For the lack of problem solving skills: I try to do more homework problems and exercises; I try to look at many examples.

- For the lack of learning resources and facilities: I go to library frequently; I look for learning materials in the Internet; University should invest more in learning resources and facilities.

In order to further explore the students’ responses on dealing with those challenging issues and to learn physics effectively, the questionnaire was designed to ask the students on learning strategies that help them learn physics effectively in lectures, in tutorials and in laboratories. The response to the question in each category from the Vietnamese students is as the following:

- 74.2% of the students answered that concentration on writing and listening in lectures would help them learn physics more effectively.

- 58.3% of the students stated that their effective learning strategy in tutorials was to finish all their homework problems prior to the tutorials.

- 41.7% of the students responded that careful reading of laboratory manuals before experimental sessions helped them perform experiments effectively.

Similar to the responses in the questionnaire, almost all of the interviewed Vietnamese students answered that their best learning strategies in physics were, for example:

- “I go to lectures regularly, listen to lecturers carefully and take notes all the information in the lectures” (V1S1).

- “I look for more references and find the necessary information from different sources” (V2S1).

- “I always revise the lecture notes and complete all the homework” (V1S2).

- “If I do not understand or I can not solve a problem, I will go and ask for help from my lecturers and from my friends” (V2S2).

There is one student who gave an advice to other students that “you should learn the knowledge of the subject from the beginning of the first day of the course and you should
not wait until the end-semester examination to learn it because at that time the amount of the subject’s knowledge is too large and you can not cover all of it” (V2S3).

The students’ responses to this question reveal that the Vietnamese students seemed to follow a routine way of learning. That is the kind of listening and writing in lectures, doing all the homework prior to the tutorial sessions, and reading and following the experimental procedure in the laboratory manuals. These responses further support the lecturers’ ‘chalk and talk’ teaching approach described in Chapter 5. The routine way of learning among the Vietnamese students is a kind of cultural orientation to knowledge, which is resulted from as far as primary school level where teachers’ authority over their students becomes very popular. From primary school level to upper secondary school level, the teachers’ popular method of teaching is transmitting knowledge via ‘chalk and talk’ and the students’ popular learning method is listening to the teachers’ information. There are rarely discussions or group work in classrooms and the students normally do not have rights to give their opinions on the teachers’ teaching methods in the classrooms.

With the same question, most of the Australian students valued group work in tutorials with other peers and with the help from tutors. Particularly, 64.6% of the students stated that the most effective way of learning physics was group work, especially in tutorials. For instance, they gave comments such as “I think small group of students and tutors is the best way of learning”, “Group work assignment questions allow for interaction so as to help understand the concept”, “Being able to discuss issues in lectures and having facilities available where groups can work on assignments together has improve the learning” (A1SG2), and “Group work is useful in tutorials and laboratories. I find I learn effectively by explaining concepts to others” (A1S2).

As described in the previous chapter, there was a similarity between the teaching in lectures in the two countries, where the number of students attending the lectures usually large. Nonetheless, the Australian students had opportunities to work in groups in tutorial sessions while the Vietnamese students rarely had a chance because the Vietnamese tutorials was also having the same number of students as in their lectures. Working in groups with the help of tutors has been identified by many researchers as an effective method of learning in the university teaching.
Besides, the Australian students also had their own learning strategies. Some examples of the strategies that they considered as effective methods in learning physics are:

- *It is very important that I see how different concepts are related to each other, how to drive formulae, and how to set up a good model to each problem and use appropriate mathematical tools (A2S1).*

- *Always draw a diagram to make it clear what physics is relevant. The write down what you know and what is required (A1S1).*

- *Doing questions that would appear in exams/tests and getting correct answers and discussion of these answers (A1S2).*

- *Understanding but with notion of basic notation is the essential part in properly explaining physics. Behavioural approach rather than learning by heart. Besides do not hesitate to ask questions: it is no harm asking (A2S4).*

The students’ responses in the interview are also in accordance with their answers in the questionnaire. However, there are still some interesting answers that need to be noticed. One of the students replied to the question as *“When I learning new physics concepts, I have pictures in my head. If you learn the pictures and understand how the formulae explain that, it is the best way to learn physics”* (A2S3) and another student had his own strategy as *“Introduction of topics and concepts with real world examples, something that can help you visualise it or understand it”* (A1S3). These students learnt physics by visualising and relating new abstract physics concepts into real things. This is a kind of modelling physics which has been identified as very effective in learning physics.

6.2. 4. Section summary

In conclusion, to overcome the identified obstacles in order to learn physics effectively, the students in both countries responded that they tried to cover the deficiencies by learning hard the knowledge and skills that they were still lacking in. Besides, the Vietnamese students effective learning methods were the hard working in lectures, homework, and laboratories by focusing on listening and writing in the lectures, by completing all the homework exercises prior to the tutorial sessions, and by reading the laboratory manual before doing experiments.
The Australian students’ responses to the question also share some similar features such as the regular lecture attendance and the completion of homework problems. However, the Australian students valued group work as the most effective way of learning physics, especially in tutorials. Some of the Australian students also stated that learning physics concepts in the relation to real world contacts and through modellings was the effective way in mastering the knowledge learnt. From the responses of the students in both countries, it can be argued that the Australian students put much emphasis on self-relevant in their learning or in other words, they possessed metacognitive skills in learning compared to their Vietnamese peers.

6.3. **Students’ reflections on the physics courses and teaching and learning resources**

This section aims to explore the students’ opinions and their satisfaction on the courses provided by the universities in Australia and Vietnam. The questionnaire and the interviews with the students focused on students’ perspectives on their learning workload, on subject modules, on the best parts of the course, on how to change the course in order to facilitate learning, and on the resources provided by the departments and the universities.

6.3.1. **Students’ opinions on learning workload**

As described in Chapter 4 and Chapter 5, the number of subject requirement in the BSc PHY physics courses in the Vietnamese universities is more than double the subjects required for the same degree in the Australian universities and the time required to complete the degree in the Vietnamese universities is nearly one thousand hours more than the time required for the Australian degree. Thus, exploring how the students in both countries think about their learning workload is of the interest of this study.

Students’ responses to the question “Do you think you have too much teaching and not enough independent study and vice versa?” were analysed and summarised as shown in Table 6.3.
Table 6.3: Students’ perspectives on learning modes

<table>
<thead>
<tr>
<th>Vietnam</th>
<th>SA</th>
<th>A</th>
<th>UD</th>
<th>DA</th>
<th>SD</th>
<th>WM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too much teaching</td>
<td>8</td>
<td>20</td>
<td>2</td>
<td>88</td>
<td>10</td>
<td>1.4</td>
</tr>
<tr>
<td>Too much independent study</td>
<td>11</td>
<td>43</td>
<td>3</td>
<td>59</td>
<td>11</td>
<td>1.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Australia</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Too much teaching</td>
<td>3</td>
<td>16</td>
<td>20</td>
<td>37</td>
<td>7</td>
<td>1.7</td>
</tr>
<tr>
<td>Too much independent study</td>
<td>5</td>
<td>24</td>
<td>22</td>
<td>28</td>
<td>3</td>
<td>2.0</td>
</tr>
</tbody>
</table>

SA – Strongly Agree, A – Agree, UD – Undecided, DA – Disagree, SD – Strongly Disagree, WM – Weighted Mean

The data on the table shows that most of the Vietnamese students agreed that they spent more time on independent study than studying in the classrooms and in the laboratories. Actually, increasing the students’ independent learning has just been implemented at several universities and colleges in Vietnam for recent years when the MOET launched “Quy chế đào tạo đại học và cao đẳng hệ chính quy theo hệ thống tín chỉ” [The regulation of training students at higher education level under credit point system] in 2007. One of the aims of this regulation is to increase and encourage independent study among students.

However, there is a contradiction to the students’ responses on the questionnaire because most of the interviewed Vietnamese students stated that the time for formal study in their universities was more than the time they spent on independent study. Particularly, six out of the nine interviewed students (66.7%) said that they were tired of spending too much time sitting in classes each day. The followings are examples of what the students said in the interviews:

- “We study nearly 20 hours a week. We go to classes every day from Monday to Friday. Sometimes we have to spend all day at the university. Our independent study time is mainly at night. In general, we spend more time at the university than independent study at home” (V2SG2).

- “I spend a lot of time for formal studying at the university. I go to class everyday so I feel a bit tired. I live in on-campus accommodation so that it’s a bit difficult to study at night time. So that we usually concentrate on learning at end-semester exam time” (V1S3).

7 In Vietnam, on-campus accommodation is commonly shared by 4 to 6 students in one room.
“In my opinion, contact time at the university is much more than independent study at home because there are many subjects and the amount of knowledge for each subject is large. I also have many other things to do so sometimes I don’t know from where I should start to learn” (V1S4)).

Two interviewed Vietnamese students said that there was an appropriate balance of studying load between formal study and independent study. One of the students stated that: “I think that time spent on studying in the university and independent study is the same amount and both require a lot of time. In lectures I am given a lot of information so that I have to spend sufficient time at home to revise and rehearse the knowledge” (V1S5). The other student commented that although the time is balanced, the new methods of teaching and learning in his university require him to spend a lot of time learning independently. There was only one student confirmed that she spent more time on independent study than formal study in classrooms. According to this student, she could not understand much the knowledge learnt in classrooms so that she had to spend much more time on independent study in order to acquire the knowledge.

The contradiction may be interpreted as the students’ misunderstanding of the term ‘independent study’. Particularly, most of the Vietnamese students filled in the questionnaire probably thought the independent study meant all of the learning time outside the classroom. In Vietnam, most of students from primary school level to higher education level spend a lot of time on learning activities outside classrooms and the operation of extra classes outside the formal school structure is considered as a disease of the Vietnamese education. According to Bui (2009), teaching and learning in extra classes inside and outside the school curriculum structure is still widespread and difficult to control. The students have to work hard outside their regular classroom because the number of subject requirements at all levels of education is usually very large and the knowledge requirement is very broad. The term “independent study” in this study is understood as “academic work chosen or designed by the student with the approval of the department concerned, under an instructor’s supervision, and usually undertaken outside of the regular classroom structure” (U.S News & World Report, 2012) and this is also the view of the MOET in an effort of its to foster independent thinking abilities that are necessary to their future careers. Nevertheless, the students were explained the meaning of the term in the interview so that what they answered in the interview was different from the questionnaire’s responses.
Similarly, most of the Australian responded that they also have more independent study over face-to-face contact learning. However, there was a bit more balance between contact time and independent study time in the Australian case. In comparison to the Vietnamese students, the Australian students had to learn fewer subjects so that the weekly contact time was also less. In addition, the average three hours contact time weekly for each subject was equally spread out as three one-hour lectures during the week so that the students had more time on learning on their own.

In the interview, most of the Australian students when they were asked to comment on the overall workload which included their contact time in the universities and their independent learning answered that the amount of the contact time and the independent study were reasonably fair and balanced. Particularly, seven out of ten interviewed students (70%) stated that the workload was fairly even. The followings are some extracts from student interviews:

- “The workload is reasonable, I think it is really good amount by three hours of lectures and enough time to go through everything in depth, and that we can then go back in refer to our book if we need more information. It gives enough time that in harder sections we can actually go through some examples and applications in actual lectures, and we can apply stuff in the labs so a lot of that done within the set university time so we don’t have to do much more at home. It means that when they say six contact hours subject, six contact hours is not really any more work. Yes, I think it is a really good balance. It’s hard to work totally independently so it’s good to have structure of the university and then independent study is definitely encouraged and required. It depends on what mark you want to get and how well you want to understand” (A1S3).

- “It’s alright. I think the balances are fine. Often we have a lot of formal study and not enough time to do the reading but I think it is always balanced at the time and then we want to do other things at well” (A1S4).

- “It’s very standard I found. I have 3 contact hours of lectures and 3 hours of prac. It’s not really long but lectures are very good. It spreads out longer week very well as well. That’s what I think” (A2S4).

However, there were two interviewed students who commented that in first year there was a balance between formal study and independent study in their physics learning but in later years (2nd and 3rd years) there was an imbalance because physics
subjects became more difficult so that students needed more help from physics teaching staff. They both suggested that the universities should increase time on formal study for second year and third year levels. Extracts of these two students’ interviews are as the following:

- “With 1st year you had probably 12 hours of lectures but you don’t need to work, you don’t need to do that much of independent study because materials were easy. As you go up to 2nd year and 3rd year, it becomes very hard. I am in 3rd year now and I had 12 to 15 contact hours (I’m not exactly sure) every week, but independent learning time I probably spend almost 40 hours a week. I am unconsciously working through weekends. It is very huge workload” (A2S1).

- “Could be more some formal study and some more guided independent study such as tutorials. In first year there are a lot of those but later on in hardest subjects, it’s more left for students to organise on their own. It’s good but sometimes you need help even it’s a group. So it’s appropriate but it may be a little bit more, may be 20% more of both” (A2S3).

Briefly, the in-depth interviews with the students at the universities in Australia and in Vietnam revealed that the Vietnamese undergraduate physics students thought they had to spend more time on learning in the classroom at the university than independent learning time. Some students even responded in the interview that they were a bit tired of sitting long hour in classrooms. Whereas most the Australian students answered that they had a balance between these time commitments. Some of the students in the Vietnamese universities also stated that the lectures usually delivered a lot of information while most of Australian students responded that they had a balance between formal study and independent study. These students’ views are further support for the comparison in Chapter 4 about the number of hours and the number of subjects that the Vietnamese students have to accomplish more subjects and more hours than their Australian peers in order to gain a Bachelor degree in physics.

6.3.2. Students’ opinions on the curriculum and syllabuses

The Australian and the Vietnamese curriculum for the BSc PHY degree encompass core physics subjects and other elective non-physics subjects. In order to get students’ opinions on the elective non-physics subjects, two questions were designed to explore their opinions on these electives. The first question was to discover the extent of
freedom with which the students are able to choose non-physics subjects. The students’ responses to this question are shown on Table 6.4.

**Table 6.4:** Students’ perspective on choosing non-physics modules

<table>
<thead>
<tr>
<th></th>
<th>Vietnam</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>a free choice?</td>
<td>5.5%</td>
<td>50.7%</td>
</tr>
<tr>
<td>free choice but recommendations?</td>
<td>4.8%</td>
<td>9.0%</td>
</tr>
<tr>
<td>some choice, some compulsory?</td>
<td>26.2%</td>
<td>16.4%</td>
</tr>
<tr>
<td>no choice?</td>
<td>63.4%</td>
<td>23.9%</td>
</tr>
</tbody>
</table>

This table shows that most of non-physics modules introduced in the Vietnamese universities were compulsory to study. Particularly, 63.4% of the students stated that they had to study these modules, and another 26.2% asserted that they had some choice and some compulsion in choosing the elective subjects. As described in Chapter 4, all of the Vietnamese first year students of all areas of study from social sciences to physical sciences and engineering have to learn a module called ‘General Education’. This module is compulsory and includes subjects such as Marxist-Leninist Philosophy, Foreign Language, Physical Education, Defence Education, Psychology, and Marxist-Leninist Political Economy. Whereas, 50.7% of the Australian students claimed that they were totally free in choosing electives for their study. Nevertheless, there were still 23.9% of the Australian students who responded that they had no choice in studying non-physics modules and 16.4% stated that they could have some choice and some compulsory in choosing elective subjects in their courses.

The students’ responses demonstrate that the Vietnamese students have less freedom than their Australian peers in choosing the subjects that may be interesting and useful for them. Importantly, the core difference between the elective subjects in the two countries lies in the meaning and purpose of what is an elective subject itself. Specifically, all non-physics subjects in the Vietnamese curriculum as described on the previous paragraph are compulsory to learn while all of the elective subjects belong to physics and the students can only choose elective physics subjects from a list of subjects specified in the course structure. These subjects may be interpreted as semi-compulsory electives because the students actually have to choose their electives among the list. Hence, these electives possibly do not have much meaning to the students in term of
their interest. In contrast, all of physics subjects in the Australian curriculum are compulsory to the students and the majority of the students can freely choose elective subjects from any areas of study provided by the universities. Therefore, most of the students are able to choose the subjects that they are interested in or the subjects that are meaningful and useful for their course or their future careers.

Furthermore, in order to have students’ opinions on the importance of non-physics modules, the second question was designed to ask students’ perspectives on studying non-physics modules and the analysed data of this question are shown in Table 6.5.

<table>
<thead>
<tr>
<th>Do you think studying these modules has been:</th>
<th>Vietnam</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>very valuable?</td>
<td>19.7%</td>
<td>43.9%</td>
</tr>
<tr>
<td>useful?</td>
<td>61.3%</td>
<td>51.5%</td>
</tr>
<tr>
<td>a waste of time?</td>
<td>2.9%</td>
<td>0%</td>
</tr>
<tr>
<td>not what I wanted to do?</td>
<td>16.1%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

It can be seen from Table 6.5 that most of the students from both countries valued these non-physics modules. Particularly, 81% of the Vietnamese students stated that non-physics modules that they were studying were useful and very valuable. This number for the Australian students was 95.4% and only 4.5% of them stated that these subjects were not what they wanted to do. There was still 16.1% of the Vietnamese students who did not want to study these elective subjects and 2.9% stated that studying these subjects was a waste of their time. The numbers shows that the Australian students seem to enjoy studying the electives than the Vietnamese students. This is possible because the majority of the Australian students had their free choice in choosing the electives that they were interested in.

Furthermore, in the interview, when the students were asked about their opinions on “what do they like and do not like in the physics course that they are enrolling in? And how should the physics curriculum be changed to facilitate your learning?”, most of the Vietnamese students responded that they were satisfied with the learning environment at their universities, the supports and enthusiasm from lecturers and peers, and the references and learning materials in the libraries. However, all of the interviewed
Vietnamese students stated that they did not like learning the ‘general education’ subjects and they also complained about the large amount of knowledge learnt. Therefore, in order to make learning more effective, the physics curriculum should be changed in a way that focuses on having more major subjects instead of these ‘general education’ subjects and on necessary and useful knowledge rather than purely academic knowledge. For instance, the followings are some extracts from the interview:

- **What I like the most is the learning environment and the library where I can find a lot of references. However, I see that there is a large amount of knowledge and most of them are required to learn by heart so I feel it is not realistic and useful because I actually need to learn something that related to real world situations. I feel that I learn physics but there is too much knowledge that does not belong to physics at all (V2S1).**

- **When I go to the library, I have opportunities to read physics references. That is what I like the most because at my secondary school I mainly learnt from textbooks and did not have many references to look for information. For the course, I think students will be more interested in learning if there are more physics major subjects and less ‘general education’ subjects (V1S2).**

- **I think that I have to learn too much and the examinations are usually difficult so that I feel a lot of pressure. However, I think it is also a good motivation to learn. In secondary school, I specialised in physical science so that in the 1st and the 2nd semesters at the university I felt bored of learning too many social science subjects (V1S3).**

With the same question, most of the Australian students answered that they were satisfied with the structure of the course. There was only one student who stated that “the least favourite in 3rd year subjects would be the tutorials because sometimes they are not worth the time. Sometimes the lecturers just go up and go to the set problems which you can read out of the textbooks. Tutorials are something that you can not read out of the textbooks” (A2S4). Furthermore, in order to make learning effective, one of the interviewed students suggested that there should be one more hour for the lectures weekly. Particularly, he said that: “I prefer there is another hour for lecture for each subject because it is rather slightly too rushed. They try to fit in slightly too much into thirteen weeks. Apart from that I do not see any how could really change” (A1S2). Besides, another interviewee gave his thought on laboratories: “I think the 1st and 2nd year labs need to be changed. I do not know how to make it better but they’re very boring. Is there attempting for you to do too hard physics in too short of time? I think the main thing is that you try to do whole experiment in 3 hours and you can’t even understand what you are trying to do over 3 hours. They need to make the labs longer in
terms of if they can make the class size smaller. That is better but that is not always possible because you do not have many lecturers and the department does not always have that much money” (A2S2).

6.3.3. Students’ opinions on teaching and learning resources

Alongside physics curriculum and syllabuses, the teaching and learning resources that the students extract from for their knowledge are also essential and very important to the students in their learning process. Therefore, a question was designed with four possible options of resources which include library, the Internet, textbooks and journals with the aim of exploring how often the students utilise these resources for their learning of physics. Table 6.6 shows the analysed data of the responses of the students in both countries on the question “How often do you use resources such as library, the Internet, textbooks, and journals for your learning?”

<table>
<thead>
<tr>
<th>Learning resources</th>
<th>AL</th>
<th>VO</th>
<th>SM</th>
<th>RA</th>
<th>NE</th>
<th>WM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library</td>
<td>5</td>
<td>41</td>
<td>80</td>
<td>14</td>
<td>5</td>
<td>2.2</td>
</tr>
<tr>
<td>The Internet</td>
<td>11</td>
<td>58</td>
<td>59</td>
<td>14</td>
<td>3</td>
<td>2.4</td>
</tr>
<tr>
<td>Textbooks</td>
<td>61</td>
<td>75</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>3.4</td>
</tr>
<tr>
<td>Journals</td>
<td>1</td>
<td>19</td>
<td>52</td>
<td>62</td>
<td>10</td>
<td>1.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning resources</th>
<th>AL</th>
<th>VO</th>
<th>SM</th>
<th>RA</th>
<th>NE</th>
<th>WM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library</td>
<td>9</td>
<td>13</td>
<td>32</td>
<td>21</td>
<td>13</td>
<td>1.8</td>
</tr>
<tr>
<td>The Internet</td>
<td>42</td>
<td>32</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>3.3</td>
</tr>
<tr>
<td>Textbooks</td>
<td>18</td>
<td>29</td>
<td>29</td>
<td>9</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>Journals</td>
<td>2</td>
<td>9</td>
<td>19</td>
<td>30</td>
<td>26</td>
<td>1.2</td>
</tr>
</tbody>
</table>

AL – Always, VO – Very Often, SM – Sometimes, RA – Rarely, NE – Never, WM – Weighted Mean

The weighted means calculated from the data show that the Vietnamese students most preferred to get physics knowledge from their physics textbooks. The Internet was the second possible resource that they often looked for learning materials. Going to find references and studying at library was also regularly chosen by many students. In the Australian universities, most of the Australian students responded that they preferred to find learning materials via the Internet. Textbooks were the second resources that the
students often learnt from followed by library. Students from both countries did not find journals as regular resources for their learning physics knowledge.

It is a surprise from the data that the Vietnamese students went to libraries more regularly than their Australian peers. The weighted means for this option of resources were 2.2 and 1.8 respectively for Vietnam and Australia. It is surprised because as mentioned in Chapter 4 the Australian universities have much better libraries than the observed Vietnamese universities’ libraries. Yet, it is possible that going to the libraries is a better option for the Vietnamese students because most of Vietnamese students live in groups at substandard boarding houses with very limited spaces. Moreover, the Australian students were able to access libraries’ learning resources from home via the Internet and services provided by their universities’ libraries.

6.3.4. Section summary

In summary, this section has revealed that the students in the Vietnamese universities spend more time learning in classroom structure than independent learning time while there is a balance between the time for teaching and independent learning in the Australian universities. Although there is a majority of the students in both countries value the important of the elective subjects, most of the students in Vietnam do not have much freedom in choosing the electives compared to a majority of the Australian can freely choose the electives that they are interested in learning. Moreover, most of the Vietnamese students do not like learning too many ‘general education’ subjects and think that they have to learn too much knowledge. They suggest that the curriculum should be changed to have more physics major subjects and to focus more on applicable and real world knowledge rather than pure academic knowledge. On the other hand, most of the Australian students are satisfied with the structure of the course. There are only two Australian students suggest that the departments should increase the time for the lecture and for 1st and 2nd year laboratories.

Finally, the students in both countries look for their learning materials from a variety of different sources. In which the order of the most frequent sources that the Vietnamese students look for their learning materials is: textbooks, the Internet, libraries, and journals while this order for the Australian students is: the Internet,
textbooks, libraries, and journals. With the advantage of ICTs, ICTs’ services and English, Australian students have more opportunities to find learning resources from the Internet. In contrast, the lack of these tools would make Vietnamese students depend on the information delivered in lectures by their lecturers, which is likely to be one of the factors that contributes towards the dominance of teacher-centred teaching approaches in the Vietnamese classrooms.

6.4. Students’ perspectives on teaching and learning practices and assessments

Teaching practice certainly are most important factors that affect the students’ learning outcomes. This section will investigate students’ opinions on teaching approaches that the lecturers employed in teaching physics in lectures, tutorials, and laboratories. It will also investigate students’ opinions on assessment practices at their universities and departments. Students’ recommendations on how teaching practices at their universities and departments should be changed to further facilitate their learning of physics will be also discussed.

6.4.1. Students’ opinions on special features that help their learning

There are many factors that affect student effective learning of physics such as teaching and learning environment, lecturer’s teaching approaches, teaching and learning resources and facilities, students’ learning attitudes, assessment practices, etc. In this study, a question was designed to explore the students’ opinions on features of teaching and learning practices that help them learn physics more effectively. Students’ responses to this question were categorised into themes and the result is shown in Figure 6.3 below.
As shown in Figure 6.3, nearly 75% of the Vietnamese students commented that teaching approaches that lecturers employed in their lectures significantly affected their learning of physics. According to these students, good teaching approaches in lectures helped them learn physics more effectively. Indeed, lectures are considered very important in Vietnamese way of learning because it is usually expected that most of the students’ learning occurs in classrooms. Coming to lectures, students are expected to understand the lectures’ knowledge and materials straight away in the classrooms. As a result, methods of teaching that lecturers employ to deliver the subject knowledge to their students are very essential to students’ effective learning.

The second graded feature that helped the Vietnamese students in their learning is the teaching and learning environment in their departments and universities. There were over 50% of the students claiming that good teaching and learning atmosphere at their universities was an advantage in their physics learning. Good learning attitude and assessment practices were the third and fourth graded features that affected their learning with over 20% and over 17% of the students respectively considered having motivation and fair assessments improve their physics learning.
Most of the Vietnamese students did not value laboratories and surprisingly none of them mentioned tutorials as helpful physics learning features. Certainly, there have been a lot of criticisms from physicists and educators about the way physics and other physical science subjects such as chemistry and biology is delivered in Vietnamese schools and universities. Traditionally, because of the lack of facilities and equipment as well as the lack of practical knowledge among science teachers, teaching and learning of physical science subjects at general education levels mainly focuses on theories but not on laboratories and practical work. According to Bui (2010), to promote students’ positive initiative, a new textbook program has been designed to include many practical work and practices but the state of ‘dạy chay’ [teaching without practices] and ‘học chay’ [learning without doing] are still very much popular at secondary school levels, especially the schools at regional and remote areas. Associate Professor Van Nhu Cuong – one of the famous Vietnamese educator – also stressed that the Vietnamese current education focuses on theoretical knowledge but lacks necessary practical skills (S.H., 2012). Thus, because first year university students have spent over twelve years of learning in this style of teaching, it is certainly very difficult for them to change their habit of learning in this style.

In comparison, the Australian students considered the tutorial was the most helpful feature in learning of physics with nearly 50% of the students who considered that tutorials helped them learn physics more effectively. This is possibly because in small group tutorials students have opportunities and chances to discuss what they think and what they have not yet understood with other students and with the help of their tutors. Whereas, the Vietnamese tutorials usually for whole classroom with over fifty students so that the students rarely have opportunities to work in groups or to get help from the tutors.

The teaching approach of the Australian lecturers in lectures was also graded as an influent factor contributing to the student learning of physics with over 30% of the students mentioning it. The laboratory was another important component in facilitating learning physics among the students following by fair assessment practices. Availability of teaching and learning resources and facilities in the Australian universities were also advantages of the Australian students in learning physics more effectively. Interestingly,
students in the two countries seemed not be concerned much with lecturers’ knowledge and enthusiasm and supports from peers in helping them learn physics. Nevertheless, the Vietnamese students graded these two features higher in term of influencing their study than the Australian students did.

6.4.2. Students’ opinions on lecturers’ teaching approaches

In-depth interview about students’ opinions on teaching approaches of physics lecturers reveals that most of the Australian students were positive about lecturers’ teaching approaches. Many interviewed students stated that factors such as examples in lectures, individual helps, in-lecture live demonstrations, slide shows, etc. helped them understand physics concepts taught in lectures. For example, these positive comments include: “the way the university does it is really good because they explain theories and go through some examples...”, “...it’s very important for lecturers to engage students, where possible to give actual examples, it’s very helpful...” (A1SG1), and “...definitely demonstrations they do in lectures are really good too, visualise and see how things work...” (A2SG1). Kinds of teaching approaches that linked physics concepts to real world contexts have been specified by many researchers as effective ways of delivering physics knowledge to students.

When being asked about whether the lecturers’ methods of delivering their lectures are more student-centred or teacher-centred, most of the Australian students responded that although the teaching methods used in the classroom were much depended on individual lecturers the teaching they experienced in the classrooms were more teacher-centred. There were two students responding that the teaching methods in third year were more student-centred because there were less students in third year classes. Nevertheless, most of the interviewed students highly valued lecturers’ efforts of trying to engage students in learning by asking questions, making discussions among students, and rehearsing the knowledge. Some of the students stated that a good lecturer is the one who “will engage the class” and “involve students by asking questions and get people to answer the questions and work though problems, which is good because it engages the students so we get the chance to think about it in the lectures” (A1SG2).
Some of the students also commented that they liked attending the lectures because of other reasons such as “I think that the lectures are good and I always go to lectures because I feel that may be they tell you something and you know what lecturers want you to do, or what they expect...”, “… lecturers give individual help if you ask for”, “… I can explore concepts more in lectures...”, and “…in lecture you get to know ideas and stuff...” (A2SG2). These comments further reveal that the Australian students enjoyed attending physics lectures because in the lectures they were able to explore and acquire physics knowledge and they also got help from the lecturers.

Besides, some students suggested possible changes to the lectures in order to help them learn more effective. The possible changes that the students would like their universities to consider are on lecturers’ teaching focus and on lecture class size. One of the students said that physics lecturers should focus on making student understand difficult concepts and issues and another student prefer small class size of the lectures because it help students learn physics more effectively. These two comments are:

- “... some lecturers progress too quickly through complex issues where they should really spend time to make sure everybody understand because if you don’t understand it earlier, later on when it comes back and you don’t know it anyway and it becomes harder” (A2S2).

- “… I find lecture having only ten students in there and that I learn a lot in that lecture because it’s almost conversation with lecturer. If you can ask questions to the lecturer all the time and then he can travel all place and he know that everyone keeping up that’s when you learn the best I think. In a big lecture, the lecturer is just talking to whole group of people, he doesn’t know if he’s moving too fast or too slow or at the right pace” (A1S3).

When the students were asked to give their opinions on effective features in tutorials, most of them valued small group discussions and tutors’ enthusiasm as factors that help them learn physics more effective. The connection between tutorials and lectures is also highly appreciated by some of the students in term of helping them learn physics effectively.

In comparison, most of the interviewed Vietnamese students responded that lecturers’ enthusiasm and their expertise physics knowledge were helpful features in physics teaching in lectures and tutorials. However, all of the students thought the
teaching methods that the lecturers used in the lectures were teacher-centred. They argued that although the lecturers sometimes asked questions and gave the students problem-based issues to solve, the teaching methods the lecturers employed in delivering their lectures are mainly presentations of the materials based on their lecture notes. Furthermore, most of the students said that the lectures usually delivered quite too much knowledge in each lecture. For instance, one of the students said that “I think the main activity in the classroom is the lecturer’s presentation of his materials to the students. Sometimes I feel tired because there is too much knowledge for a three one-hour lecture in a half day. Sometimes there are only some students listening to the lecture because most of students feel very tired and bored” (V2S3).

The Vietnamese students suggested that the lecturer should focus much on the main points of the lectures in order to reduce the amount of knowledge delivered in each lecture. They also recommended that the lecturers needed to use more ICTs in their teaching to visualise some difficult and abstract physics knowledge and make the lectures more interesting. Furthermore, when being asked about what teaching approach the lecturers should use to make you learn physics more effective, most of the students agreed that the lecturers’ materials should link to real life applications and to the recent development of technology, and the lecturer should also encourage students to find out applications related to the knowledge learnt in the lectures via sources such as the Internet.

6.4.3. Students’ opinions on assessment practice

The assessment practice plays an important role in facilitating and fostering students’ learning because assessment is a way of knowing how well the students understand the knowledge taught. However, not all of the assessments are successful in assessing the students’ performance. Therefore, the study would like to have an insight into how the students think about the assessment of their learning at the departments and how it should be changed to make their learning of physics more effective.

In the Australian universities, the assessment of the students’ learning for a particular physics subject usually comprises marks from three components: about 15% of weekly assignments, 25% of ongoing assessment of practical work during the
semester, and 60% of written examination in the examination period. In response to the interview’s question on students’ opinions on how accurate the method of assessment is in assessing the students’ knowledge and ability, all of the interviewed Australian students answered that the assessment do not really reflect their physics knowledge and ability. The common replies are, for example: “I don’t think the current system adequately assesses ability...” and “The assessment does not really reflect the student ability...”.

Many Australian students stated that the written examination occupies for 60% of the total marks for a particular physics subjects is a bit too much. Responses from the students such as “I do not think the exam should be worth as major component of the unit... I don’t think it should be worth 60% to 70% of the subject”, “…it is very high percentage in exam. For one exam is very heavy load because students may be haven’t understood or may be memorising something” were recorded during the interviews. Some of the reasons that the students thought why the written examination should not be worth as the current assessment practices of the departments are: “exam is stressful”, “the test is multiple choice, and sometimes the students just guess... The final exam is a lot of memorising... There’re similar questions to the pass exam papers... Questions in exam are similar to questions in problem classes, therefore study problem classes will pass exam”, “…you know a problem so you can do it in exam but it is not really testing your knowledge about the subject”, and “...probably it does not reflect what students know but reflect what students know at the time of the exam, and after exam they may forget the knowledge”.

The students went on suggesting that in order to reflect students’ knowledge and ability the assessment at the departments should be changed. Particularly, all of the interviewed students stressed that the departments should reduce the importance of the end-semester exam and should increase the continuous assessment of assignments and ongoing assessment of practical work during the semester. For instance, the following are the recommendations of the students on assessment practices to the departments of physics:

- ... I think it should be based on assignments when you’re given problems and you have to work on them for a couple of weeks and also they should be more research assessment like I’ve done some assignments where we had to look
up papers that talked about the experiment that showed something and then described that and that is really good learning experience (A1S1).

- ... Some exams are written fairly well but should be based more on progressive work such as assignment and discussion topics. More small assessment rather than a big exam. Exam is good but exam for nearly whole subject is too much (A2S4).

- ... I think it is better exam worth less so may be 50%, so lab work, tutorials should be worth a bit more because that also judges your ability why you learn it, how quickly you learn it and how well you understand it (A2S3).

- ... I think the assignment do because you spend the time to learn the things and you do problems... and I’ve found also the labs we have to do lab reports which are difficult but it is good thing to do to practice writing about what you did, explaining what you’ve done. I think that is really good assessment (A1S3).

- ... Probably more small assessments such as a larger things than actual assignments or something over a period of time or smaller may be even in-class assessment or something that give people more chance rather than actually one huge thing (A2S1).

- ... I think it’s better to have slight on the exam and more way throughout the semester, that way you can study through the semester rather than just two weeks at the end (A1S4).

On the other hand, nearly 67% of the Vietnamese interviewed students answered that they thought the assessment at their departments reflected accurately their knowledge and ability, and only about 33% stated it was not correctly assessed their true physics knowledge and skills. The reason that most of the Vietnamese students think the assessment adequately reflects their physics knowledge and ability is because the end-semester written examinations are usually very strict and difficult. Nonetheless, some of the students suggested that the departments should increase and include more variety of assessment approaches such as writing essays and doing small projects and research.

6.4.4. Section summary

This section has explored the students’ opinions on teaching and assessment practices at the department of physics both in Australia and Vietnam. The data from the questionnaire and the interview shows that most of the Vietnamese students value the teaching approach of the lecturers in the lectures as the most helpful feature in learning physics, and almost all of them do not consider the laboratory and the tutorial as factors
that contribute to their physics learning. In comparison, nearly 50% of the Australian considers the tutorial is the most helpful feature in learning of physics following by teaching approach in the lectures and the laboratories. Although the Australian students do not value much on lecturers’ teaching approaches in the lectures, most of them were positive about what the lecturers do in the classroom to help them learn physics effective. All of the interviewed Australian students answered that the assessment practice at their departments do not correctly reflect their physics knowledge and ability and recommend that the assessment should be changed to have more regular assessment of assignments and practical work and reduce the importance of the written examination. Whereas, most of the Vietnamese interviewed students stress that the assessment accurately reflect their physics knowledge and ability because the written examinations are very strict and difficult. Some of the Vietnamese students suggest that there should be more variety of the assessment such as marking on essays and projects.

6.5. Chapter summary

This chapter has revealed the students’ perspective on undergraduate teaching and learning of physics in the universities in Australia and Vietnam. The lack of practical and problem solving skills are their biggest challenges of most of the Vietnamese students in learning physics while most of the Australian students have difficulties in dealing with the lack of mathematical and physics background and their motivation in learning. To overcome these obstacles, the Vietnamese students work hard in lectures, homework and laboratories while the Australian students choose to work in small groups, especially in tutorials.

Students’ learning experience in the departments revealed that most of the Vietnamese students spend more time on learning in classroom structure than independent learning, and they do not have much freedom in choosing the elective subjects. Most of the Vietnamese students responded that they do not like studying too many ‘general education’ subjects because they prefer to learn physics and other major subjects that related to their areas of studies. Whereas, the Australian students said that they have a balance between the time in face-to-face contact and the independent learning time, and most of them are satisfied with the structure of the course. They also had their freedom in choosing electives that were useful and interesting. There were only
two Australian students recommended that the departments should increase the time for lectures and for 1st and 2nd year laboratories.

The students’ learning experience also shows that most of the Vietnamese students value the teaching approach of the lecturers in the lectures as the most helpful feature in learning physics while most of the Australian considers the tutorial is the most helpful feature in learning of physics following by teaching approach in the lectures and the laboratories. The students in both countries thought that the teaching methods that the lecturers applied in their lectures were very much teacher-centred. Nevertheless, the Australian valued the approaches such as asking questions and relating the knowledge to real life context and applications. In order to make learning more effective in lectures, some of the Australian recommended that the departments should reduce the class size while the Vietnamese students thought that the lecturers should utilise more ICTs in their teaching and the teaching materials should be included real life applications and recent technology development.

All of the interviewed Australian students answered that the assessment practice at their departments do not correctly reflect their physics knowledge and ability and recommend that the assessment should be changed to have more regular assessment of assignments and practical work and reduce the importance of the written examination. Whereas, most of the Vietnamese interviewed students stress that the assessment accurately reflect their physics knowledge and ability because the written examinations are very strict and difficult. Some of the Vietnamese students suggest that there should be more variety of the assessment such as marking on essays and projects.
Chapter 7. Physics Lecturers’ Perspectives on Undergraduate Physics Teaching and Learning Practices

Chapter 6 has described students’ perspectives on the undergraduate teaching and learning of physics at the six universities in Australia and Vietnam. To further investigate and to have deeper insights into the teaching and learning practices at these universities, this chapter will explore how physics lecturers perceive physics teaching and learning practices at their physics departments and universities. Particularly, this chapter will investigate lecturers’ perceptions of: (i) physics teaching and learning practices at their universities; (ii) undergraduate physics programs provided by the universities; (iii) guidelines and support from their physics departments and the universities; (iv) changing processes and innovations that have happened at their departments and universities; and (v) future directions of undergraduate physics practices in their universities and their countries.

This chapter also explores opinions of a number of Australian physics innovators who have recently had many publications in the field of tertiary physics education. It will investigate how these physics educational researchers view changes, reforms, and directions in the future of university physics in Australia. Similarly, the opinions of some Vietnamese physics educators were collected at the Vietnamese national physics education conference held in Hanoi in October 2010. This conference’s themes were: “Chiến lược phát triển Vật lý Việt Nam đến 2020” [Strategies of Physics Development in Vietnam to 2020] and “Giảng dạy vật lý và cử nhân vật lý tài năng ở bậc đại học” [Teaching physics and Bachelor of Physics for excellent students at tertiary level].

The lecturers’ perspectives on teaching and learning practices were investigated by using questionnaires and interviews while opinions of the Australian physics innovators were explored through interviews. The questionnaire is divided into two sections: Section 1 is about lecturers’ opinions on teaching and learning practices for undergraduate physics at the universities; and Section 2 is about their opinions on changes, drivers for change and future directions of teaching and learning in undergraduate physics at their universities. The interview questions for the lecturers aimed to further clarify the information collected from the questionnaire.
7.1. The demographic of lecturers participating in study

There were nine Australian lecturers, four education physics innovators and two heads of physics departments from the three universities in Victoria participating in this study, of which five lecturers participated in both interview and completing the questionnaire. In the Vietnamese universities, the number of physics lecturers participating in this study was ten, of which seven lecturers took part in both interview and completing the questionnaire. The data collected from these respondents were categorised and grouped into themes for analyses using quantitative and qualitative methods.

7.1.1. The Australian lecturers

There were six Australian physics lecturers completing the questionnaire, of which there were two level D Associate Professors, two level C senior lecturers, and two level B lecturers. Five out of the six lecturers who completed the questionnaire also participated in in-depth interviews, while three other physics lecturers at the departments of physics who participated only in interviews. In addition, four physics education innovators, and two heads of the departments of physics also participated in interviews. The four physics innovators were well known for their contributions to physics teaching and learning practices at their universities. With their expertise in the field, their contribution to the study is very valuable.

The teaching experience of the participants is also important for the study because it is likely to provide a clearer picture of physics teaching practice at these physics departments. Particularly, among the Australian lecturers, four lecturers had over ten years of physics teaching experience and one lecturer had over five years of physics teaching experience. Furthermore, the lecturers taught a wide range of physics subjects including introductory physics and specialised areas of physics, which is also a benefit to the study because they have experience in teaching different topics.

Table 7.1 shows the range of physics subjects and physics specialised areas that six Australian physics lecturers taught in the departments of physics.
Table 7.1. Australian lecturers’ range of physics subjects and areas taught

<table>
<thead>
<tr>
<th>Lecturers</th>
<th>Physics subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1L1</td>
<td>Physics for Life Sciences; Space Science Instruments; Remote Sensing; Neutral Atmosphere; Climate, Sustainability and Society</td>
</tr>
<tr>
<td>A1L2</td>
<td>Modern Physics; Atomic and Nuclear Physics; X-ray Physics</td>
</tr>
<tr>
<td>A1L3</td>
<td>Physics for Life Sciences; Thermal and Statistical Physics</td>
</tr>
<tr>
<td>A2L1</td>
<td>Physics for Biomedicine; Physics Fundamentals; Thermal Physics; Experimental Methods</td>
</tr>
<tr>
<td>A2L2</td>
<td>Physics I; Physics II; Advanced principles and applications of sensors</td>
</tr>
<tr>
<td>A2L3</td>
<td>Advanced Physics; Physics for Biomedicine; Climate change; Electromagnetism; and Experimental methods</td>
</tr>
</tbody>
</table>

The average number of hours that these lecturers directly participated in their teaching activities in lectures, tutorials, and laboratories was 6.3 hours weekly. Among them, one lecturer spent twelve hours of contact time every week on direct involvement in physics teaching practice and two lecturers had only 4 hours of weekly teaching practices. Besides direct involvement in teaching in lectures, tutorials and laboratories, the lecturers spent their time doing research and other administrative duties. This study focuses on the time that the lecturers were directly involved in teaching activities in lectures, tutorials and laboratories.

7.1.2. The Vietnamese lecturers

In Vietnam, there were seven physics lecturers completing the questionnaires, of whom three lecturers also participated in interviews. There were also other three lecturers who participated only in interviews. Among them, three lecturers had more than twenty years of experience in teaching physics, three lecturers had more than five years of teaching experience, and two lecturers had less than five years physics teaching experience. There was an Associate Professor and four senior lecturers. These lecturers also taught a wide range of physics subjects for undergraduate students. In particular, there were two lecturers delivering physics education subjects to the students whose future career would be physics teachers at secondary school levels.
Table 7.2 shows the subject range taught by physics lecturers completing the questionnaires in Vietnam.

**Table 7.2. Vietnamese lecturers’ range of physics subjects and areas taught**

<table>
<thead>
<tr>
<th>Lecturers</th>
<th>Physics subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1L1</td>
<td>Introductory physics which included: Mechanics, Heat and Thermal physics, Electromagnetism, Optics, and Modern physics</td>
</tr>
<tr>
<td>V1L2</td>
<td>Introductory physics, Physics education</td>
</tr>
<tr>
<td>V2L1</td>
<td>Introductory physics, Technical physics, Digital Technology, and Optical Cable Technology</td>
</tr>
<tr>
<td>V2L2</td>
<td>Introductory physics, Fluid Mechanics, and Theories of Systems</td>
</tr>
<tr>
<td>V2L3</td>
<td>Introductory physics</td>
</tr>
<tr>
<td>V3L1</td>
<td>Methods of Teaching Physics, Philosophies of Teaching Physics, Methods of General Physics Experiments</td>
</tr>
<tr>
<td>V3L2(^8)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7.1 shows the weekly direct contact hours of the Australian lecturers and the Vietnamese lecturers.

![Figure 7.1: Lecturers’ weekly direct contact hours](image)

It can be seen from figure 7.1 that all Vietnamese lecturers spent over 10 hours weekly on teaching activities in classrooms while there was only one Australian lecturer spent more than 10 hours weekly in direct teaching. Especially, there was one Vietnamese lecturer who had 30 hours of directly involvement in teaching physics in the classroom. It can be calculated that the average number of hours that the Vietnamese

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\(^8\) One lecturer did not respond to this survey question
lecturers directly participated in their teaching activities in lectures, tutorials, and laboratories was 16.9 hours per week while that for the Australian lecturers was 6.33 hours weekly. In comparison, the Vietnamese lecturers thus spent an average of 10 hours per week more than that of their Australian counterparts in the classroom. The large amount of time that the Vietnamese lecturers spent on teaching activities in classroom is likely the result of the large number of subjects and content required for the BSc PHY degree and it also reflects less focus on research.

7.2. Physics lecturers’ beliefs and practices

This section will investigate the lecturers’ beliefs and opinions on current teaching and learning of undergraduate physics at their departments based on the data collected using questionnaires and interviews. It will investigate the lecturers’ opinions on their own physics teaching practices in lectures, tutorials and laboratories, and their opinions about the relationship between research and teaching. This section will also investigate how the lecturers implement their beliefs concerning effective university physics teaching and learning into actual practices in the classroom.

7.2.1. Australian lecturers’ opinions on physics teaching in lectures, tutorials, and laboratories

Teaching is a complex task that requires instructors to use a variety of strategies to effectively support student learning. Teaching methods and strategies that lecturers employ in their teaching in different contexts in turn depend on the learning outcomes set out for a specific topic, for a subject or for a course. They also largely depend on the lecturers’ conceptions of good practice in undergraduate teaching and learning of physics. Therefore, to understand the lecturers’ opinions concerning the current teaching and learning practices in undergraduate physics at their departments and universities, the survey and interview questions were designed to investigate their conceptions of good tertiary physics practice, the important outcomes that they aim at for students, and the teaching strategies that they use in lectures, tutorials and laboratories to facilitate effective student learning.

As described in the literature review chapter, the constructivist theory of learning stresses that effective teaching and learning should focus on student-centred teaching
approaches. Student-centred means the teaching is more responsive to student learning needs. From a constructive perspective on learning, this involves students being given the opportunity to actively shape and construct their learning. Many educational researchers agree on the effectiveness of student-centred teaching approaches in supporting student learning because these teaching methods encourage students to be more active in their learning by engaging in activities such as asking questions, sharing ideas, and giving feedback based on their learning experiences (Carini, Kuh & Klein, 2006; Mulhall & Gunstone, 2007).

Teaching Approaches in Lectures

In this study, most of the Australian lecturers agreed that good practice in teaching and learning of physics was the kind that encourages students to be actively involved in their learning process. For example, in the interviews, most of the lecturers’ responses to the question on the conception of good practice in teaching and learning of physics were that good physics teaching practice should engage students in a variety of learning activities. The following examples are from interview responses of three Australian lecturers:

- “... You really need to engage them. So doing everything you can to engage the students is essential. Teaching also, I think, it is helped by reflection and interaction among the students... with demonstrations, I ask student to predict what they think will happen. That is another chance for engagement too...” (A2L2).

- “... I am teaching them how to be aggressive, in a good way not in a bad way. But being aggressive helps learn it better, faster and in more efficient way...” (A1L1).

- “... I think good practice in teaching and learning of anything not just physics involves interaction and communication...” (A3L1).

In order to engage students in their learning process, the lecturers said that: “I always put new materials into my lectures’ slides ... and change the materials based on students’ needs”(A1L1); “... putting a problem to the class, asking students to discuss among themselves and then tell them what is the answer is. I think that is a powerful way of getting student engagement...” (A2L3); and “... I think if students have to ask questions and have to answer questions verbally, if they have to talk not just back to the
lecturer but also to other students and discuss in groups and so on, this more helps people learn...” (A3L1).

The lecturers’ constructivist views on good physics teaching practices were also shown through their criticism of traditional approaches to teaching. Most of the lecturers did not value rote learning strategies, which traditional teaching approaches can lead to. Some lecturers strongly opposed the methods of teaching that usually drive students into rote learning. For example, two of the lecturers said:

- “... It’s never ever made any sense that you stand there and write down loads and loads of information about physics and having students write it down in their books and go away to read. That’s never been a good way to learn” (A2L2).
- “... So I think traditionally in the universities we have had teaching and learning based in lectures where students sit there and listen while a lecturer talks to them. It is not a conversation. It doesn’t go two ways” (A3L1).

The traditional teaching approach that these two lecturers described above and criticised is often termed teacher-centred instruction in which lecturers present physics materials and occasionally perform demonstrations while students listen, take notes and rarely raise questions or make comments. In a teacher-centred classroom, teachers play an active role by directing students’ learning activities and setting what and how students will learn and be assessed, whereas students are passive recipients of new knowledge in their learning process. This traditional instruction has been widely considered to be ineffective in helping students develop a more scientific view and conceptual understanding of physics.

Instead, most of the interviewed lecturers stressed that the most important outcome that they aimed at for the students was their “ability to think”: to be able to solve problems in a variety of situations and able to derive higher level formulae from basic ones. They also emphasised skills such as reading skills, practical skills and communicative skills. The following examples are some extracts from the lecturers’ responses to the interview question on the important outcomes that lecturers aim at for students:

- “... I think the most important outcome that I aim at is their ability to think ... because memorising is not going to work...” (A2L3).
“... Remembering a minimum amount that you can get away with, and being able to quickly derive the higher level formulae. So I don't think it is useful anywhere to teach someone to just remember by remote second order differential equation, some process or whatever. If they just use $f = ma$, $e = mc^2$ and derive higher level formulae then I think that is where real learning in physics comes from...” (A2L2).

“... Learn how to solve problems, not just necessarily textbook problems, more real world problems as well. Both problems can be written down as mathematical type questions, or quantitative problems, also technical problems in laboratories... Learn how to help themselves find stuff out, know how to read. Understand core knowledge and can you tell me how to solve this problem (don’t need to give answer). Use computers to solve problems...” (A3L1).

“... They are able to teach themselves in the area of physics, ability to communicate technically, to understand in depth knowledge...” (A2L1).

“... that is a problem here in Australia that many students use the formula, find the formula from formula sheets or from the text books and sometimes they just use explicitly what sort of formula should be used for the problem and then just plug the values from the problem and get the answers. That is not the way that we teach. They need to develop a deeper understanding of physics...” (A1L2).

“... development of understanding of new subjects, by the end of the week: be able to solve problems...” (A1L3).

Critical thinking skills and problem solving skills are important outcomes for students that are developed via a process of active involvement of students in their learning such as discussions and interactions among learners and between them and instructors. Many lecturers agreed that having critical thinking skills, students did not need to remember all information delivered in lectures. Instead, they needed to understand fundamental knowledge and be able to derive and understand higher level physics knowledge. According to these lecturers, these learning outcomes are achieved by engaging students in their learning activities using interactive engagement teaching approaches in the classroom.

Other interactive teaching approaches that some lecturers described using in their lectures included peer learning, using clickers, and PEERWISE – a multiple choice question system on computer. These approaches in teaching have been identified as effective methods in engaging students in learning physics in lectures as discussed in the literature review chapter. These lecturers’ responses seemed to indicate that they were
not only aware of contemporary teaching and learning theories but also utilised these in their own practice in order to help their students learn physics effectively. These examples also indicated the lecturers’ understanding of the ineffectiveness of traditional teaching approaches in helping students learn.

In order to further understand how the lecturers employed methods of teaching that facilitated active learning in the students, a survey question explored their teaching strategies used in lectures, tutorials and laboratories. Their responses for lectures are shown in Figure 7.2. The data indicates that the Australian lecturers use a variety of active teaching strategies in their physics instruction in lectures.

![Figure 7.2: Australian lecturers’ teaching strategies in lectures](image)

The figure shows that using ICTs and problem-based teaching are two approaches that most of the lecturers used in their physics instruction in order to help students learn physics more effectively. Additional information from their responses shows that the ICTs the lecturers used in their lectures included PowerPoint presentations, online learning materials, online lecture notes and mixed-media lectures featuring physics simulations and animations. The availability of ICTs and the use of a variety of ICTs in the teaching of most of the Australian lecturers potentially gave the students opportunities to learn on their own initiative by accessing learning materials via the Internet. These teaching strategies make it possible for students to be actively involved in their learning process by choosing what and where they learnt. This
potentially has the effect of reducing lecturers’ authority over students’ learning compared with teacher-centred approaches.

A problem-based learning approach is a constructivist approach where students are given a real problem to explore, think and solve based on their own experience and knowledge under the guidance of instructors. Problem-based teaching and learning is widely considered as an effective student-centred teaching approach in terms of developing students’ knowledge, understanding, and problem solving skills. In the problem-based learning classroom, students have the opportunity to actively participate in group discussions to express and exchange their ideas and learn from others to find a resolution to the problem. In this process, they develop not only problem solving skills but also thinking skills, communicative skills and analysing skills. These skills are of critical importance to students’ educational, professional and personal lives in a fast-changing global economy (Crebert et al., 2011).

Besides those two important approaches in teaching, the lecturers also claimed to use a variety of other methods in their physics instruction. Particularly, two lecturers used live demonstrations in their physics teaching, which were largely appreciated by the students as shown in the previous chapter because the in-class demonstrations made the lectures more interesting and helped the students in visualising physics concepts. Individual student presentation and student group presentation in front of the whole class were also employed in physics teaching by two lecturers. In addition, interactive concept test questions, inquiry-based learning, and group discussions were also claimed to apply in teaching in lectures by some of the lecturers.

*The Lecturers’ Beliefs and Their Actual Practices*

Based on the data described in Chapter 5, there is broad agreement between lecturers’ responses to the question on teaching strategies they employed in their teaching and the actual teaching practices observed in their classrooms. For instance, the in-class observations showed that all of the Australian lecturers used ICTs to deliver materials to the students in lectures. In-class live demonstrations were also employed to teach physics in some lectures in the Australian University 2. Summaries and examples, student discussions and concept tests were used in the observed lectures in the
Australian undergraduate physics courses. Though, a problem-based learning approach was not observed in their teaching in the lectures.

However, despite the fact that most of the lecturers expressed a belief that teaching approaches that engaged students in active learning were effective teaching methods, not all of the lecturers agreed that the way of teaching and learning of undergraduate physics in the Australian universities promoted active learning in the students. In particular, the following example is an extract from the interview with one of the lecturers:

“... It is also the Australian way of practice... Most of our second year students, their interaction is they come to three lectures a week and a laboratory class, and then in the lectures, still, mostly they are just listening. I think that we know that it doesn’t work so well. It has been studied and we know that it is not a good way to learn... So I think if students have to ask questions, if they have to answer questions verbally, if they have to talk not just back to the lecturer but also with other students and discuss in group and so on, this is more help people learn and it is normal interaction of human in any societies, and I think that is a better learning environment...” (A3L1).

Student-centred teaching and learning methods such as problem-based learning, context-based learning and inquiry-based learning approaches were not observed in the Australian undergraduate physics lectures at the studied universities. Instead, almost all the observed lectures were still a very much teacher-centred teaching approach. Particularly, in most of the observed lectures, the students’ main activities in the lecture theatres were listening to the lecturers and annotating their lecture notes while the lecturers presented their materials.

When asking about what kinds of teaching approaches these lecturers employed in their physics teaching in lectures, most of them described how, although they had tried to make their lectures as student-centred as possible by “asking questions”, “giving examples”, “using clickers” and “asking the students to discuss with other peers sitting next to them”, their teaching methods were still very much teacher-centred. The following extract is another example indicating that teacher-centred teaching approaches in lectures are still dominant in undergraduate physics practice in the Australian universities:
“... a lot of the teaching that I do, it is still teacher-centred because when I give lectures I try to make the lectures a bit interactive: I ask the class questions, I ask them to stop and wait for someone to answer and we discuss and so on but it is still people watching me, so it is still teacher-centred, I guess” (A3L1).

The teaching in lectures that this lecturer described was observed in all of the studied lectures in the Australian universities. In these lectures the lecturers still directed what and how the knowledge, learning activities the students would take, as well as the methods of assessment. In contrast, in a student-centred classroom, the lecturer plays a role as that of a facilitator, enabling students to learn in a way that best caters for their learning needs. Student-centred teaching approaches focus on students’ learning outcomes rather on teaching, and students have the chance to actively participate in activities that are helpful for their understanding of new knowledge.

**Teaching Approaches in Tutorials**

Although most tutorials in the Australian universities are run by graduate students, there is a close collaboration between physics lecturers at the departments and the tutors. Particularly, in the tutorials that were observed, only the lecturers in the Australian university 1 were directly involved in teaching tutorial sessions. The main roles of these lecturers in this university were as supervisors and instructors who facilitated student learning in the tutorial sessions. This university also had online quizzes that required the students to discuss in groups before completing the quizzes.

In the other two universities, the tutorial instructors were graduate students at the departments of physics. While there was not much direct participation of the lecturers in tutorial sessions in the Australian universities, all of the lecturers expressed strong support for the active teaching and learning practices in the tutorials at their departments. For example, one of the lecturers valued the collaboration work between physics lecturers and graduate students in running tutorial sessions, in which the graduate students “put a great deal of effort” into their roles as tutors.

As described in Chapter 5, the tutorials in the Australian universities were organised in small groups of students with an average number of approximately twelve students for each tutorial session. As a result, there were more interactions between students and between students and tutors in the tutorials than in the lectures. The
teaching and learning method in the tutorials was a kind of student-centred approach, with the students actively involved in their learning activities while the tutors played the roles of facilitators.

The student-centred teaching approaches in tutorials are also reflected in the lecturers’ responses. The following examples are typical lecturers’ responses to the questions on teaching strategies that they employed in tutorials:

- “...Getting students to work in groups... Discuss their answers with each other and with the lecturer... No working on board... Encourage students to work and think...” (A2L2).

- “… to have students to work in groups to solve the problems themselves and for them to all agree that they got the right answers before they move on to the next problem. That promotes discussion between them. People who think that they know the answer are often challenged to explain why that is the right answer. And when they have to explain it they might realise that they’re right or they may realise that they’re wrong... tutors just go around and encourage discussion...” (A2L1).

- “…Online problems and classes... Extended two hours problem class held to engage students during on campus time...” (A1L2).

- “…Online quizzes (design all questions myself)... Workshop tutorials...” (A1L4).

- “…Concepts and applications to specified areas are introduced and discussed via solving problems...” (A1L1).

- “…Workshop and context tutorials...” (A1L3).

- “…At first and second year levels, tutorials are designed in collaboration by the first year lecturers, and presented by graduate students. This approach has been very successful: most of the graduate students put a great deal of effort into doing their tutorials well, and students are very positive about the experience...” (A2L3).

Their responses showed that in order to get the students actively involved in discussion as well as encourage them to participate in solving homework problems and exercises, the instructors used a variety of student-centred teaching approaches in the tutorials such as group work, workshop tutorials, collaborative work on online problems and quizzes.
Generally, the teaching approaches in the tutorial sessions focused on the active involvement of students in the learning process, in which small group work and discussion, workshop tutorials and online problems for small group students were utilised. These kinds of teaching approaches are much more student-centred than the teaching approaches that the lecturers used in their lectures.

Teaching Approaches in Laboratories

Undergraduate physics laboratories in the Australian universities are generally run by demonstrating teams who are academic coordinators, undergraduate laboratory coordinators, and graduate students as demonstrators. Thus the lecturers, to some extent, are not involved much with teaching and learning activities in the laboratories. Therefore, two lecturers responded to the question on effective teaching strategies in laboratories thus: “I circulate during laboratories and show interest in student learning” and “they are normal labs”. Another lecturer responded that new computers and modern laboratory equipment were contributory factors in helping students learn physics in laboratories at the department. “Active learning laboratories with group discussion” and “small online components to ensure that students are familiar with the lab before they attend” were also laboratory teaching methods employed in physics laboratories as described by another two lecturers.

Relationship between Research and Teaching

Because physics is a practical science, teaching by linking physics theoretical knowledge with practical application is considered an effective way to motivate student learning and help them understand the importance of the physics knowledge they are learning to technology development. Most of the Australian lecturers were recruited as physics researchers in the departments and at the time of the interviews, they had done a wide range of research in physics, which includes areas such as atmospheric physics and space science, x-rays, properties of particles, quantum optics, and lasers. This study investigates how the physics lecturers connect their research to their teaching and how important is the relationship between research and teaching in undergraduate physics practices.
Most lecturers said that they delivered physics subjects that were connected to their research strength. For example, the lecturer whose research area was quantum optics and lasers delivered optics in second year level; the lecturer with research strength in space science taught atmospheric physics; and the lecturer with his research area in ultra-cold electrons delivered particles physics. They responded that they tried to connect what they had done in research to their teaching whenever it was possible by “having some slides of my research and how it is connected to what students are doing at the time”, or “giving them some special topic lectures about my research...”, or “…giving students project-based learning exercises, which is about setting up open-ended problems for students to solve…”, or “… updating my teaching materials...”. One of the lecturers also said that his university “has long time encouraged people to use examples from their research or from current research around the world in their teaching... so research-led teaching is the term that they use...”

All lecturers valued the importance of what research brings to teaching and most lecturers also valued the important role of teaching in doing their research. Though, there was one lecturer who said that: “Teaching does not help research. It slows down the research because the majority of time spent on teaching is time taken away from research” (A1L1). The lecturers’ responses on the benefits of research to teaching and vice versa can be summarised into categories as shown in the following columns:

<table>
<thead>
<tr>
<th>Benefits of research to teaching</th>
<th>Benefits of teaching to research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturers’ expertise</td>
<td>Excite students about doing research</td>
</tr>
<tr>
<td>Provide appropriate examples</td>
<td>Remember basic physics knowledge and mathematical processes</td>
</tr>
<tr>
<td>Encourage students in learning</td>
<td>Provide concepts and analysis techniques to future research students</td>
</tr>
<tr>
<td>Promote discoveries</td>
<td></td>
</tr>
</tbody>
</table>

The benefits that research brings to undergraduate physics teaching are enormous, according to the lecturers. Firstly, by doing research lecturers will certainly have expert knowledge on their physics research areas and that potentially makes their teaching more effective and productive. Secondly, with the expert knowledge on physics subjects, lecturers are able to “provide students with examples... that provide them with more interesting things rather than just equations on the board... here is what happens...”
in real life... I can talk about my company development of lasers and my electronics...”, and “take examples from cutting-edge research and use it to inspire students in my class...”. These examples show students how physics theories translate to applications. Thirdly, when students know how physics knowledge is connected to real life applications, they will see the meaningful aspect of the knowledge providing motivation in learning. Finally, students from two studied universities were provided with “research-based learning exercises, which they were able to do their research as scientists”. This research-base learning approach not only “promotes real and positive experience in a specific field” but also “promotes cutting-edge discoveries in the field”.

In turn, “teaching provides direct interaction with students, and an opportunity to excite students about doing research, in particular my own research. Thus, this is an avenue for mentoring and enlisting future graduate students to my group...”. Teaching also helps lecturers “keep a range of mathematical and physical processes current in my mind” and “teaching also ensures I am constantly reviewing many areas of physics, which offers new ideas and avenues for future research. It also ensures I know my basic physics well, which is always valuable in doing research”. Finally, “teaching aids in explaining concepts and analysis techniques to research students” and it also “improves communication skills to both small and large audiences”.

Summary

Overall, all of the Australian lecturers valued the kind of teaching that encourages students to be actively involved in their learning processes and criticised traditional teacher-centred teaching approaches in helping students learn physics effectively. In order to make students more active in their learning, the lecturers used a variety of ICTs in their lectures to help students visualise physics knowledge and its applications. Although the lecturers said that they used many different teaching methodologies in their lectures such as problem-based leaning, context-based learning, and concept tests, the teaching in lectures as described by some lecturers was still teacher-centred.

However, most of the lecturers described how the teaching in tutorials and laboratories employed student-centred learning methods. The main approach employed
in teaching in tutorials and laboratories was group work. Therefore, in tutorials and laboratories, the students had opportunities to work on their own and to discuss their understanding with other peers and with their instructors, which they did not have many chances to do in lectures. This student-centred learning approach in tutorials, lectures and laboratories was strongly supported by many lecturers and most of them perceived that it was very successful in helping students learn and understand physics concepts.

All Australian lecturers participated in doing research in important areas of physics such as quantum optics, lasers, ultra-cold atoms, space science... and most of them delivered physics subjects that were related to their research strength. They said that in their process of teaching, they tried to give students examples from their research when it was suitable to use these. All of them valued the importance of research to teaching and vice versa. Particularly, they responded that doing research would enrich teaching by providing examples, talking about research, and connecting theories with applications, hence promoting and inspiring student learning of physics. Teaching was also good for research because it helped lecturers strengthen physics knowledge and processes. Besides, teaching provides concepts and analysis techniques to research students and importantly excites students about doing research.

7.2.2. Vietnamese lecturers’ opinions on physics teaching in lectures, tutorials, and laboratories

In Vietnam, there is at least one national physics education conference for higher education held annually. These conferences are usually organised by the MOET which encourages physics teaching staff of higher education institutions in the whole country to attend. At these conferences, the physics teaching staff attend presentations by physics educators and experts in the field of physics education. They also have opportunities to discuss and exchange their experiences in teaching and learning practices at their universities with their colleagues from other higher institutions. Therefore, the conferences are considered excellent opportunities for lecturers to be exposed to contemporary teaching and learning theories as well as effective teaching methods, in order to apply these to their own teaching.
In this study, a similarity was found in lecturers’ perspective on undergraduate physics teaching and learning pedagogy between the Australian and Vietnamese universities. Particularly, most of the interviewed Vietnamese lecturers also supported teaching approaches that drew students into a process of thinking, and teaching that focused on applications and real life phenomena. In Vietnam, physics is largely considered a practical subject, so that, theoretically, good physics teaching is usually required to be linked to empirical examples. The following examples are some of the lecturers’ responses to the question on good physics teaching, that focus on applications:

- ... Physics is a practical science therefore good teaching of physics not only focuses on teaching theories but also relates the theories to reality and shows students the applications of the theories in technology... (V2L1)

- ... When you teach physics you should give students examples and applications that are relevant and related to everyday life situations. You should also ask students to give examples related to the knowledge they are learning and make them think and answer your questions. Besides, creating a good teaching and learning atmosphere in classrooms is also important because it will encourage and motivate the students... (V3L3)

- ... I usually try to find out examples of applications of the physics knowledge that I am going to teach through different sources, especially the Internet. I find that my students really focus on those interesting examples; and I think that would help them to remember what they are learning... (V2L2)

- ... Effectiveness in teaching physics is to make students like learning physics because only when they like learning the subject will they be motivated... (V1L2)

The method of teaching whereby lecturers present knowledge to be learnt on a blackboard and sometimes give examples and ask the students questions was popularly used in all of the observed lectures in the Vietnamese universities. This method of teaching is the quintessential teacher-centred learning approach, in which students are the passive recipients of what they learn.

One of the lecturers highly valued the kind of teaching that develops cognitive development in the students. This lecturer responded that:
... I think teaching is not only a process of transmission of teachers’ knowledge to students but it also teaches students how to think and reason (V1L2).

This lecturer also went on to generalise that the teaching in most of Vietnamese higher educational institutions was still very traditional because “most of the teaching methods in Vietnamese universities and colleges do not focus on learning activities which develop students’ thinking ability and creativity”. The teaching that drives students into a process of imitation of what teachers do has been criticised by many Vietnamese intellectuals.

This issue has been used as a topic of debate in a national university entrance examination’s literature examination paper for the students to write an argumentative essay. The topic, which was a quotation from a Vietnamese American psychology graduate named Tran Hung John, who was famous for walking across Vietnam without money to experience Vietnamese people’s lives, was: “Most of the Vietnamese have passive personality, who are the followers but not the pioneers. If there was someone who went ahead and tried first, I would follow him but I would never be the leader. The pressure of society makes you follow an already existing programme” (MOET, 2013).

The Vietnamese lecturers’ response to the survey questions on their teaching strategies used in lectures to achieve students’ learning outcomes that they most valued are shown in Figure 7.3. As can be seen from the figure, there is a similarity in the Vietnamese lecturers’ responses compared to their Australian counterparts. Particularly, ICTs and problem-based learning were claimed to be used in lectures by most of the lecturers. Group work and group discussions were also accounted for by over 40% of the responses that these approaches were used in physics teaching in lectures by the lecturers.
However, there is a disagreement between the lecturers’ response in using ICTs in their teaching and their actual practice as observed in their lectures, described in Chapter 5. In all of the observed lectures in the Vietnamese universities, the lecturers mainly used chalk and talk in their teaching. The ICTs and their services that the Vietnamese universities provided were also insufficient for the students to utilise them for their learning. Particularly, none of the observed lecturers were taught using ICTs and there was only one university providing online lecture notes to students.

Problem-based teaching and learning was also a popular teaching approach chosen by the lecturers as four lecturers said they applied this method in their teaching. Especially, group work and group discussion are highly encouraged by the MOET to be major teaching approaches in Vietnamese schools, colleges and universities in order to make students more active and more involved in their learning. However, using group work is not so effective in Vietnamese classrooms due to the fact that there were usually a large number of students attending lectures. In the interview, one of the Vietnamese lecturers responded that “it is difficult to successfully implement this teaching approach with a large number of students in each class. I have tried to use group work in my teaching but there are some students who do not actively participate in the discussion...
and therefore it is difficult to let everyone learn equally. Some learn a lot but some do not learn at all” (V1L1). Another lecturer even stressed that “I think there are few topics for which physics lecturers can apply group work in their teaching. But we can not use this approach in most of the physics program because we have too much knowledge to deliver to students under time constraints...” (V3L2).

Teaching Approaches in Tutorials

In the Vietnamese universities’ tutorials, all of the students of a class9 normally attend tutorial sessions together and the lecturer who teaches theory in lectures is also the instructor in tutorials. There is no distinguishing feature between a tutorial session and a lecture in term of class setting, except for the teaching content. The following examples are the Vietnamese lecturers’ responses to the survey question on teaching approaches that they used in their tutorial classes:

- Mark students’ homework; Ask students to solve problems by themselves; Explain to them what they do not understand.
- Give problems for groups; Give homework for individual students.
- Small essays; Group discussions.
- Doing homework at home and having group discussions in tutorials.
- Ask two to three students to come to blackboard to solve the same problems in different ways and different methods; I then compare and explain to students the benefit of each method.
- Discussions and make reports.
- Group work; Each student solves the problem in front of whole class.

As can be seen from the responses, the lecturers described the use of several teaching strategies in tutorials. Four lecturers responded that they valued group work in tutorials. One of the lecturers had several students publicly solve the same problem using different methods in order to compare the benefit of each method in problem solving of physics. This kind of problem solving encourages students to think and to incorporate different physics concepts to be able to solve the problem in different ways.

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9 In Vietnam, tertiary students are group into classes like primary and secondary schools in Australia. Each class has about 40 to 50 students and they usually study together until they graduate.
Tutorial teaching strategies such as writing small essays and reporting on discussions were also employed by the Vietnamese lecturers in their tutorial teaching.

Individual students solving problems on blackboards in front of the whole class, which was described by three lecturers as a regular teaching method in tutorials, was frequently used in the Vietnamese tutorial sessions. The public exposure of students’ problem solving in front of the whole class is a common teaching method in Vietnamese tutorials, which students experience as early as primary school level. It is a common belief in Vietnamese education that people are afraid of losing face in public and they try hard to avoid it. Therefore, in using this method of teaching, it is likely that the lecturers expect it encourages students to try hard in doing their physics homework.

**Teaching Approaches in Laboratories**

Responses from the Vietnamese lecturers on their special teaching strategies in laboratories are the following:

- **Modelling**: Provide some website addresses for online experiments
- **Students do real experiments and simulations**
- **Online practical work**: students learn from lectures and short films before doing experiments
- **Create experiment apparatus by myself for teaching purposes**

These responses from the lecturers show that most lecturers appreciated the using of ICTs in physics laboratories such as modelling, online experiments, simulations, and short films illustrating the experiments that students were going to do. One of the lecturers made his own experimental apparatus to illustrate physics concepts to students.

However, there is a disagreement between the lecturers’ responses and the observations of demonstrators’ and students’ activities in the Vietnamese undergraduate laboratories. As described in chapter 4 and 5, most of experimental instruments in the Vietnamese undergraduate physics laboratories did not connect to computers and the Internet. Teaching and learning activities in these laboratory sessions followed a pre-programed procedure.
Relationship between Research and Teaching

There is a major difference in practice between physics lecturers in Vietnamese universities and Australian universities. In the Australian universities, according to some lecturers, they were employed mainly to do research. In the process of the employment interview, their research expertise and research skills were considered by staff of departments of physics, but not their teaching experience and teaching ability and skills. In contrast, physics lecturers in Vietnamese universities are commonly employed to teach physics. In order to get a teaching job at university level, most candidates have to go through a teaching test, in which they have to deliver at least one lecture to undergraduate students under the observation of physics departments’ examiners. Only candidates who have good physics knowledge, good pedagogical skills, and good communicative skills can qualify for the job. Their research expertise and research abilities are just additional criteria in the employment process.

The physics lecturers in the Vietnamese universities spent most of their time on teaching undergraduate physics and doing research was not their priority as in the Australian universities. Though, some of the Vietnamese lecturers undertook their research on physics education and there were two lecturers who participated in doing research on nano-materials and solid state physics.

When asking about the connection between research and teaching, these two lecturers responded that the expertise that they brought into classroom was really helpful. “I have good physics knowledge and good mathematical skills so that helps me teach physics more effectively...” (V2L1) and “people who are doing research usually have good physics knowledge, so when they teach that would help students understand physics better” (V3L2). They also brought their research examples into their lectures by “telling my students what I am doing” and “giving them an idea of what is nanotechnology and how lightweight materials are produced and that really impresses them”.

Some lecturers whose research area was physics education responded that their research closely connects to their teaching. Particularly, one of the lecturers said “my research topics usually arise from my experience in teaching students... and in turn, my
research helps to improve teaching practice in my department” (V3L3). They also stressed that “knowing how students learn physics and what are their weaknesses in order to fill the gaps is important”. The following examples are their responses on the benefits of doing research to teaching and vice versa:

<table>
<thead>
<tr>
<th>Benefits of research to teaching</th>
<th>Benefits of teaching to research</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Research helps teach more effectively</td>
<td>- Teaching gives ideas and direction of doing research</td>
</tr>
<tr>
<td>- Research improves teaching staff’s knowledge</td>
<td>- Teaching makes research become more logical</td>
</tr>
<tr>
<td>- Research connects theories to real life applications</td>
<td>- Teaching reveals issues for conducting research</td>
</tr>
</tbody>
</table>

The benefits that research brings to teaching, according to some Vietnamese lecturers, are “research enriches teaching and makes teaching more interesting” and “research helps lecturers have more useful information for teaching” because “research helps in connecting theories to reality, improving professional knowledge, and updating new knowledge”. In turn, some of physics education research lecturers said that “teaching helps improve research results” and “teaching practice gives me ideas of doing research”. There was a difference in responses to the question on the relationship of research and teaching between the Australian and Vietnamese lecturers. All Australian lecturers conducted research in physical science areas while some of studied Vietnamese lecturers conducted their research in physics education.

**Summary**

In general, the Vietnamese lecturers’ responses on teaching approaches that they used in lectures, tutorials and laboratories show that they are fully aware of the importance of using active learning approaches in facilitating students’ learning of physics. Particularly, group work and group discussion were strongly supported by many lecturers as effective teaching methods that encouraged students to actively participate in their learning processes. The Vietnamese lecturers also understood the importance of ICTs as effective means in delivering physics knowledge in lectures and laboratories. Most lecturers described that they used ICTs in their teaching in lectures and in the laboratory.
However, the lecturers’ perspectives on effective teaching and learning of physics seem not to be supported by the observations of their practice or the existing facilities. The problem of inadequacy of ICT facilities, equipment and teaching and learning resources could be a main factor that affects the lecturers’ willingness to use ICTs to deliver lectures and to teach in tutorials and the laboratory. Therefore, teacher-centred teaching approaches were still dominant teaching methods in the Vietnamese physics departments. The large number of students in undergraduate physics classrooms and tutorials as described by several lecturers is also a restraint factor in organising group work and group discussion. As a result, the lecturers seemed to not have many choices with respect to implementing active student-centred learning pedagogies in their teaching rather than using a chalk and talk style of teaching.

The Vietnamese lecturers focus on delivering lectures in classroom and do not consider doing research as their priority. However, all lecturers valued the important relationship between research and teaching. Most lecturers said that doing research helped teaching be more effective because research connected theories to reality and helped lecturers have up to date knowledge. Some of them who were involved in education research also stressed that teaching gave them the opportunity to understand what were problems with student learning of physics, so that they had topic ideas to do research.

7.2.3. Summary of the lecturers’ beliefs and practices between the two countries

The lecturers in both countries believed that interactive student-centred teaching approaches would make students learn physics effectively. Their responses suggest that they employed a variety of teaching approaches in lectures, tutorials and laboratories such as problem-based learning, group discussion, workshop tutorials, teaching with integrated ICTs. They also had similar opinions on the ineffectiveness of traditional teacher-centred teaching approaches in helping students understand physics. For instance, some of the lecturers in both countries criticised the traditional methods of teaching that drove students into memorising physics facts and knowledge. From their beliefs, it is certain that most lecturers in both countries had good knowledge on contemporary constructivist perspectives on learning and on pedagogy.
However, in actual practice, the methods of delivering lectures in the universities in both countries were quintessential teacher-centred learning because the main activity in the lecture theatre was lecturers’ presentation of physics knowledge. Nevertheless, some of the Australian lecturers integrated interactive teaching approaches in their presentation such as using live demonstrations, using PowerPoint slides with handout notes available for students to annotate, and incorporating simulations and animations of physical process into their lectures. On the other hand, all the observed lectures in the Vietnamese universities were traditional teacher-centred chalk and talk teaching approaches, where students listened and copied all the information the lecturers wrote on blackboards.

The Australian lecturers had greater chances to utilise ICTs in their teaching in lectures, tutorials and laboratories than their Vietnamese counterparts. Especially, the ICTs that the Australian lecturers used in their lectures were more noticeable both in quantity and quality than the Vietnamese lecturers. The availability of ICTs and teaching and learning resources in the Australian universities might be considered as supporting factors for the teacher-centred teaching approaches that students experienced in lectures. With the availability of ICTs, Australian students had opportunities to access their learning materials and be able to learn on their own initiative. The availability of ICTs and the adequate infrastructure and experimental equipment were also contributory factors in helping students experience a learning environment that was related to physics research laboratories. This experience potentially benefits students in preparing themselves for future careers as physicists or careers in physics related areas. In contrast, the lack of that infrastructure in the Vietnamese universities led students into relative dependence on the information provided by their lecturers compared to their Australian counterparts.

The contrast between teaching approaches in the two countries is more obvious in tutorial sessions. Particularly, although the Vietnamese lecturers valued group work, individual students solving physics problems on the blackboard in front of the whole class was employed in all Vietnamese undergraduate physics tutorials. The possible reasons for using this teaching approach in the Vietnamese tutorials are the large number of students attending tutorial sessions and the established tradition of getting students to
work hard under the pressure of public exposure in front of the whole class of students. On the other hand, all the Australian tutorials were small group tutorials, where students had opportunities to learn in a student-centred learning environment. In these small group tutorials, students could express and exchange their understandings of physics problems with peers and tutors. They, therefore, have the opportunity not only develop problem solving skills but also communicative and cooperative skills.

In teaching and doing research, most of the lecturers in Australia and Vietnam said that both teaching and doing research were important and the link between research and teaching was helpful for their professional development and for the effective teaching. However, because all of the Australian lecturers were also researchers of leading areas in physics while all of the Vietnamese lecturers mainly focused on teaching, there were differences in their responses on the relationship between research and teaching. Particularly, the main responsibility of the Australian lecturers is doing research; hence the quality and results of their research are the most important. At the same time, the research expertise of the Australian lecturers brought their research skills, cutting-edge knowledge, and applications into the classroom to show students the meaning of physics theories that they are learning. In contrast, because most of the physics lecturers in the Vietnamese universities conducted their research in physics education, they seemed to do research to improve their teaching. Therefore, most of their research topics arose from their teaching experiences in classroom and the findings were applied back to the classroom.

7.3. **Lecturers’ opinions on teaching practices at the departments of physics**

This section investigates the lecturers’ perspectives on features of physics teaching and learning practices provided by their departments of physics. These features include teaching and learning conditions and resources, physics curriculum and syllabi, and teaching staff and students. This section also investigates guidelines for their teaching practices and supports for professional development provided by the departments and the universities.
7.3.1. Opinions of the Australian lecturers

On Physics Teaching Practices

Responses from the Australian lecturers on special features of physics teaching at their departments were analysed by colour coding transcripts to identify common themes. Features that are particular successful in their teaching can be summarised into five factors. The first factor that contributed to the effective teaching and learning of physics was the staff and students at the departments. Most Australian lecturers valued the enthusiasm of teaching staff, tutoring and demonstrating teams as special features making the success of physics teaching at the departments. These responses include: good staff commitment on teaching; great tutors and good demonstrators; and the high quality students enrolling in physics degree.

Effective teaching has been identified by many studies to be the important factor responsible for quality of learning. Having good teaching staff and good instructors in the departments is definitely advantageous to effective student learning. In this study, responses such as “most teaching staff at our department are extremely helpful and enthusiastic” were common. The standard of students enrolling in the BSc PHY degree is also an important factor contributed to quality learning. For example, one lecturer said that “the students that we get are coming from at the top-end of the students in Victoria and around Australia, so that makes life much easier in term of teaching...” (A2L2).

However, there were some negative responses from the lecturers about problems such as the poor mathematical and physics background of students and the large amount of teaching workload. Those were constraints affecting the quality of physics teaching practices at their departments. For instance, when being asked about the students’ background, one lecturer responded that “students’ background on mathematics and physics are quite bad compared to Canada and the United States... They have very poor knowledge of basics...” (A1L1). The shortages of physics staff that result in large workload was also expressed by a lecturer as he said “we have not enough staff for the number of students and we also do not have enough staff to effectively support administration of the teaching program. For example, to run the whole teaching laboratory program for second year, there is one laboratory technician... that is really
not enough people... We do not have enough lecturing staff, so a number of people who are giving lectures in second year are post-doc or people who are like me supposed to do research only. So I think staff shortage is a problem...” (A3L1).

The second factor contributing to effective teaching of physics in the departments was teaching approaches and strategies employed by the lecturers. Most of the lecturers answered that they and their colleagues used appropriate teaching methods that facilitate learning in the students. The teaching approaches that the lecturers applied in successful teaching situations were:

- interactive learning such as quizzes and problem solving on board
- well organised materials and presentation; the use of appropriate demonstrations
- teach students how to think; run lectures like Discovery Channel; keep students engaged
- encourage active learning
- great lecture demonstrations
- using clickers, project-based learning exercise

The responses from the lecturers show that most of the lecturers were of the opinion that using appropriate interactive teaching approaches in each context of the physics classes could engage students in effective learning activities. In-lecture demonstrations were considered a successful feature in teaching physics at the departments because there was positive feedback from students.

The third factor is the adequate teaching and learning infrastructure provided by the departments of physics and the universities. Basically, many Australian lecturers agreed that teaching and learning infrastructure and resources in their departments and universities were satisfactory. The following examples are some of their positive opinions on their departments’ infrastructure and resources:

- ... I would say it is pretty good compared to what I have seen in Canada and in some other places. I really like that most our lecture rooms are equipped with computers and connected to the Internet and it has white board and projectors... we have dot com projectors where we can put papers and solve problems in front of students... so I am happy with teaching facilities here (A1L1).

- .... We have excellent teaching resources, some of which are quite unique in Australia. We have a collection of lecture demonstrations and I do not think many other departments in Australia have such a great collection, and we
devote substantial resources to those demonstrations... So I think it is a big difference (A2L3).

- ... Facilities and resources are really good such as physical infrastructure and computers. Space that we’ve got is quite good, it is not overcrowded (A3L1).

There were, however, two lecturers who responded that they needed to be funded more to improve their departments’ physical infrastructure, especially undergraduate physics laboratories. Particularly, one of the lecturers said that “we’re desperately short of money to improve the first year laboratory. We need to spend hundreds of thousands of dollars to bring them up to the standard of a private secondary school for example... so we are dealing with equipment that is from 1975” (A1L4). Similarly, “... we still require more money to buy modern equipment for our teaching practicals. We also need building resources...”, said another lecturer (A3L1).

The fourth factor is the subject content delivered to the students at the departments. Most of the Australian lecturers felt positive about the physics content delivered to the students. These positive features of the content include:

- links to research emphasised where it is possible (A2L3).
- theory supported by relevant and examples accessible; working through examples in lectures (A2L2).
- I can make any material interesting; linking to real life works everywhere; helping students to understand hard stuff makes them very happy. The content then is not important (A1L1).
- Emphasis the physical meaning rather than mathematical formulations (A1L4).
- We have moved to a broad general degree, and it is not yet clear if this has been a positive move. Students seem less interested in depth, and less scholarly and more vocational. Involvement with current research is very positive, particularly at higher years where the smaller student numbers make it possible to bring students into research environment directly (e.g. lab experience) (A2L1).

It can be seen from their responses that the physics lecturers highly appreciated how important was the link between the physics content and the available research at the departments as well as real word contexts. Learning physics in real life contexts and in laboratories is considered by many physics educators as a meaningful and effective way
for students because physics itself is an empirical subject. Two lecturers also responded that focusing on making students understand physical meanings of physics phenomena was more important than focusing on the content of physics lectures and mathematical formulae.

The fifth factor is the assessment practices at the departments. According to the lecturers, the combination of formal end of semester tests and continual assessments such as assignments, online quizzes, in-lab assessments, informal tests, and in-semester tests was a very effective way of assessing student learning of physics. Using a variety of assessment methods is likely to help in assessing students’ physics knowledge in a timely, effective and valid manner. The inclusion of physics formulae and mathematical derivations in physics examination papers as described by some lecturers was also considered a good way to help students focus on understanding the meaning of physics and its applications rather than rote learning by trying to remember them.

On Guidelines and Support from the Department and University

Lecturers’ responses to the question on the degree of freedom in their teaching practices are shown in Table 7.3.

**Table 7.3: Degree of freedom in Australian lecturers’ teaching practices**

<table>
<thead>
<tr>
<th>Teaching Practice</th>
<th>VM</th>
<th>SW</th>
<th>UD</th>
<th>NR</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choosing or modifying subject content</td>
<td>17%</td>
<td>67%</td>
<td>0</td>
<td>16%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing teaching methods</td>
<td>67%</td>
<td>33%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Choosing textbooks and references</td>
<td>17%</td>
<td>50%</td>
<td>17%</td>
<td>17%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing kinds of student assessment</td>
<td>0</td>
<td>83%</td>
<td>0</td>
<td>17%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing teaching time for subject content</td>
<td>0</td>
<td>34%</td>
<td>17%</td>
<td>17%</td>
<td>34%</td>
</tr>
</tbody>
</table>

VM – Very much, SW – Somewhat, UD– Undecided, NR – Not really, NA – Not at all

As can be seen from the table, most of the Australian lecturers said that they had quite a lot of freedom in choosing subject content for topics they were teaching, choosing teaching approaches in their lectures, choosing teaching materials, and choosing methods of assessment. The amount of time used to teach topics’ content was somewhat fixed, as 17% lecturers said that they did not really have freedom in choosing
teaching time for the subject content and 34% responded that they did not have freedom at all in choosing time for what they taught.

Although lecturers have freedom in their teaching practices, they have to follow guidelines set up in subject handbooks to ensure the quality of student learning. The quality assurance for undergraduate physics involves a constant process of review and feedback from academics, teaching staff and students. For example, “twice a semester, we [staff and students liaison committee] invite representatives from all classes and all lecture streams to meet and discuss how the course is going, so we monitor directly. We also have student monitoring processes plus an end of year feedback form” (A2L1). All of the lecturers also said that the feedback from students through surveys was important. For example, “we take those surveys very seriously and we address the issues ... the real thing is how well the students know physics when they finish...” (A2L1).

Moreover, to ensure effective teaching, all of the studied universities provided support to their teaching staff. Lecturers’ responses show that all universities had teaching workshops open to all staff members:

- There are teaching courses offered by the university, and staff can go and attend.
- We have several teaching workshops run by the university and these workshops are very useful...
- The university has an academic centre of development and I did participate in a couple of events. It is helpful to some extent
- Recently the university provide 3 days course for teaching staff

7.3.2. Opinions of the Vietnamese lecturers

On Physics Teaching Practices

Most Vietnamese lecturers considered special features of physics teaching at their departments to be qualifications of teaching staff in their departments. They stated that the quality of physics teaching depended largely on the physics knowledge and pedagogical knowledge of instructors. For example, some lecturers said that “the most important factors [in effective teaching] are teaching staff qualifications and methods”, and “preparation of good lectures and having good physics knowledge”. The teaching
staff’s enthusiasm and motivation for improving their physics and pedagogical knowledge in teaching was also stated as an important feature in fostering the quality of student learning. For example, one of the lecturers described “young teaching staff who have motivation and are eager to learn new things” as an effective feature in helping student learning.

Some of the lecturers argued that in order to make student learn physics effectively, lecturers needed to have good contemporary pedagogical knowledge. According to these lecturers, in order to create an effective learning environment, teaching staff should “get students involved in their learning by using problem-based learning, group discussion and real life examples, and know how to encourage independent learning in students by instructing them how to collect knowledge, information and how to analyse this knowledge.

The second factor that contributed to the quality of undergraduate physics teaching practices, according to most of the Vietnamese lecturers, was the strong mathematical and physics background of students and their enthusiasm and motivation in learning. One of the lecturers said that “we are lucky because most of our students are very good at calculus and physics, especially the students enrolling in physics for talented courses10”. As described in Chapter 4, undergraduate physics students in most Vietnamese universities have learnt a substantial amount of physics and mathematics in secondary school, hence they have strong background in physics and mathematics. This is an advantage for undergraduate physics teaching and learning practices in terms of quality of student learning.

Students’ motivation in learning is also an advantage in having high quality undergraduate physics teaching practices. Traditionally, Vietnamese students are fond of learning because most Vietnamese people consider learning as a way to escape from poverty and having a degree in higher education means having a brighter future. As a result, students are usually pushed by their parents into learning hard from as early as primary school level. Therefore, “our students have great enthusiasm and motivation in

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10 Two studied universities provided physics and engineering courses for talented students. These courses have advanced curricula adopted from some universities in The U.S and most of the subjects are taught in English.
were common responses of the Vietnamese lecturers as a factor that contributed to quality of their teaching at their departments and universities.

Most lecturers’ responses on physics curriculum and content of syllabi were quite negative because most of them did not consider those as successful features in their teaching. Particularly, they stressed that the large amount of content and the lack of application knowledge were factors needing to be changed to bring more success into undergraduate physics teaching practices as well as in training good physics graduates. The following examples are some typical extracts from interviews with the lecturers:

- “... I think that the physics curriculum embraces a lot too much knowledge in a wide range of subjects...” (V2L2).

- “... in today’s world, graduate students should know how to create materials for society, so teaching should be in line with applications. Our curriculum still has quite a lot of knowledge that is not really necessary...” (V1L2).

- “... Our teaching has been changed to a way that encourages independent learning in students. However, in my opinion it is still incomplete because it is difficult to encourage student independent learning when there are a large number of subjects with still too much knowledge...” (V3L1).

The inadequacy of infrastructure and the lack of teaching and learning facilities, equipment and resources were common complaints by the lecturers as discouraging factors in the process of improving physics practices in their universities. For example, “most of our laboratory teaching and learning equipment is out of date and more needs to be invested”, “the teaching and learning resources are very poor”, “classrooms lack modern equipment such as projectors and computers connected to the Internet”, and “tables and benches are not suitable to implement a group discussion teaching approach” were common responses from the lecturers.

**On Guidelines and Support from the Department and University**

The Vietnamese lecturers’ responses to the question on the degree of freedom in their teaching practices are shown in Table 7.4.
Table 7.4: Degree of freedom in Vietnamese lecturers’ teaching practices

<table>
<thead>
<tr>
<th>Teaching Practice</th>
<th>VM</th>
<th>SW</th>
<th>UD</th>
<th>NR</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choosing or modifying subject content</td>
<td>0</td>
<td>43%</td>
<td>0</td>
<td>57%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing teaching methods</td>
<td>43%</td>
<td>43%</td>
<td>0</td>
<td>14%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing textbooks and references</td>
<td>14%</td>
<td>57%</td>
<td>0</td>
<td>29%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing kinds of student assessment</td>
<td>14%</td>
<td>14%</td>
<td>0</td>
<td>72%</td>
<td>0</td>
</tr>
<tr>
<td>Choosing teaching time for subject content</td>
<td>0</td>
<td>43%</td>
<td>0</td>
<td>57%</td>
<td>0</td>
</tr>
</tbody>
</table>

VM – Very much, SW – Somewhat, UD– Undecided, NR – Not really, NA – Not at all

As can be seen from the table, that the lecturers did not have much freedom in choosing methods of student assessment with 72% of them responded that they were not really able to choose how students were to be assessed. A majority of the lecturers (57%) also responded that they could not really choose and modify subject content and teaching time for subject content. However, most of the lecturers responded that they had quite a lot of freedom in choosing teaching approaches and teaching materials in their teaching.

Similarly, in the interview, most lecturers said that they had to strictly follow guidelines from the universities on content of subjects’ syllabi in term of detail of physics knowledge as well as the order of topics. For example, two lecturers said that “I have to write down the topics that I am delivering to students into a record book\(^{11}\) so that the department knows whether I follow the syllabi or not” (V3L1) and “in my teaching, I have to cover all the topics and follow the time set out for each topic as indicated in the subject syllabus” (V1L2). The lecturers also answered that the departments of physics required lecturers and teaching staff to have at least a meeting every week to discuss their teaching practices in that week. However, most lecturers said that although their universities encouraged them to use interactive teaching approaches in their teaching, they had a lot of freedom in selecting methods of teaching. For instance, “I use a teaching approach that I think it is suitable for the topic teaching. The

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\(^{11}\) Every class in most Vietnamese universities has a common record book for all lecturers teaching in that class to write down their teaching activities such as teaching topics, date and time of their teaching, and any special issues or problems happening in their lectures and grade how well are student learning. One of the departmental staff has responsibility of monitoring this book to summit to the academic teaching board.
most important thing is that students understand the physics knowledge that I deliver” (V2L2).

In recent years, the MOET has promoted a student-centred teaching approach in all levels of education. It organises annual conferences on effective teaching and learning in higher education and encourages lecturers to attend. Therefore, all of the lecturers in this study responded positively on the support that they received. For instance, one of the lecturers stressed that “the MOET and the university encourage us to use interactive teaching approaches in our teaching. Therefore they provide conferences on physics education, where we have forums and workshops to discuss interactive pedagogy” (V3L3).

7.3.3. Section summary

In response to the successful features associated with their teaching in their departments and universities, both the Australian and Vietnamese lecturers valued the enthusiasm and good physics and pedagogical knowledge of teaching staff as important factors contributing to the quality of undergraduate teaching practices. The Australian lecturers also valued the contribution of tutor and demonstrator teams in supporting effective student learning.

The strong background on physics and mathematics of undergraduate physics students were also considered by all of Vietnamese lecturers and some of the Australian lecturers as a contributing factor in quality of student learning in their departments. However, some Australian lecturers criticised the inadequate preparation of physics and mathematics at secondary school levels for the first year undergraduate physics students. They stressed that the students’ poor background in physics and mathematics were constraints affecting the quality of physics teaching practices at their departments.

While most Australian lecturers identified the quality of teaching and learning infrastructure, facilities, equipment and resources to be one of their advantages in creating an effective learning environment, all the Vietnamese lecturers stressed that in order to improve the quality of teaching and learning, departments and universities should invest more money in installing more modern equipment, especially in physics laboratories and ICTs.
Similarly, most of the Australian lecturers felt positive about the physics content delivering to students because they thought that the link between the physics content with the available research and real world contexts was meaningful way in teaching physics. They also valued the effectiveness of using a variety of assessment methods. Whereas, most Vietnamese lecturers believed that in order to bring more successful to undergraduate physics teaching and learning, the physics curriculum should be changed in a way that reduced the amount of content and included more application knowledge.

In response to guidelines and support from the departments and universities, the Australian lecturers had more freedom than their Vietnamese counterparts in choosing or modifying subject content and in choosing methods of assessment. Some of the Vietnamese lecturers said that they had to strictly follow the guidelines set out in subjects’ syllabi in term of content and time used to teach, while some of the Australian lecturers responded that they were able to choose what they taught as long as it yielded student learning outcomes set out in the subject handbook. Most lecturers in both countries answered that they were satisfied with the support provided by their departments and universities for their professional development.

7.4. Lecturers’ perspectives on challenges, changes and future directions

This section will present how the lecturers in both countries perceive challenges in their undergraduate physics teaching practice in recent years and what they and their departments and universities have done to overcome those challenges. It will also investigate the lecturers’ opinions on how undergraduate physics teaching practice should be in the future to improve the quality of physics teaching and learning.

7.4.1. Australian lecturers’ perspectives on challenges, changes and directions

Challenges and Changes

The lecturers’ responses on challenges and the changes that they had made to improve student quality of learning are summarised as shown in the following columns:
Challenges

- Students’ poor background on mathematics and physics
- Students’ lack of engagement
- Lack of funding
- High student/teacher ratio

Changes

- Revise course structure
- Modernise course structure
- Introduce new courses
- Changes in teaching approaches and teaching content

As described in the previous section, some of the lecturers stressed that the poor mathematical and physics background of students was a constraint affecting the quality of physics teaching practices at their departments. Not only the students in first year but also the students in second year were still lacking in mathematical background as described by one lecturer:

“...in the start of second year they do not have knowledge of the Fourier transform, and that is a problem because it is really really important to understand the Fourier transform before you do condensed matter physics, before you do quantum mechanics, before you do atomic molecular physics... so they are lacking some core mathematical skills, particularly the Fourier transform and differential equations... They are also lacking in data handling skills in the teaching lab, so their ability to handle and propagate uncertainty is very limited at the start of second year... They have no idea how to propagate uncertainties through equations. We do not do a good job of teaching that even in second year...” (A3L1).

Another lecturer even criticised the university on its student intake as “the university is accepting almost all students with very low marks, and making most of them pass to meet the budget goals” (A1L1).

To address this problem, the physics departments and the lecturers have made many changes. For example, at departmental level, they “put a great deal of effort in training tutors and demonstrators to have good knowledge and skills so that they know how to help students learn effectively”. They have tried to “integrate the learning in laboratories and the learning in lectures and tutorials and try to make sure that all of those pieces work together”. They have also removed some of the subjects’ content to meet students’ abilities and needs and simplified the laboratory requirements. The lecturers also reacted to this problem by breaking up materials into smaller components,
revising teaching knowledge before and after each lecture, and giving students notes and information.

The problem of students’ lack of engagement in learning was also reported by some lecturers. For instance, one of the lecturers said that “many students now have a job outside university, it limits time to study, so that student engagement is difficult to maintain”. The issue of students’ lack of enthusiasm in learning physics was also described by two lecturers:

- “the number of high-achievers is probably falling, due to a cultural emphasis on earning lots of money and on prestige (e.g. medicine, law); fewer bright students are doing physics for the love of it...” (A2L2).

- “Students have become less interested in physics in the recent years. More efforts should be spent on outreach programs to promote physics and science in general” (A1L3).

Therefore, the departments and the lecturers also addressed this issue seriously by putting more materials online, changing curriculum to focus on “more vocation” to answer students’ question of “What job will this get me?” and encouraging lecturers to use a variety of interactive teaching approaches to promote student engagement in their learning.

The lack of funding seems to be the most serious challenge because all the lecturers responded that the quality of undergraduate physics teaching and learning was affected by under funding. The following is a response from two of the lecturers:

- “I think in the near future things are going to get worse because we are very under funded... All the universities in Australia have significant salary income reduction for the amount of students we teach. More and more students but not more money. So in the near future, we will be offering less courses, larger classes, more students in each class. I think that is going to happen more and more. We’ve just deleted one subject, and I think we will lose another one in the future, and we have to keep losing them until we get more funding basically from government” (A3L1).

- “Australian universities are drastically under-funded by the Australian government. Australian students rely on cross-subsidisation from foreign fee-paying students. Until that changes, our teaching will be highly constrained by budget limitations” (A2L1).
The lack of funding also results in the lecturers’ large amount of workload because of the higher ratio of students to teachers. Particularly, the lecturers representing all three studied universities responded that they did not have enough staff in their departments to cover teaching, research and administrative jobs. For example, “we also have fewer and fewer teaching and research staff. The department has shrunk from approximately 25 teaching and research academics to approximately 12 academics” (A1L3). According to some lecturers, the solution for this problem was to increase the class size; hence there were a large number of students in each class. One of the lecturers also responded that “last year we were faced with a big increase in the number of first year students, so we were going to make our budget too big for demonstrators, so we looked carefully at ways we can save money; and we decided on a kind of a different course structure as a result of that. So instead of having the lab marked at the end of the lab. The lab now is assessed in class...” (A2L2).

Resistance to the Changes

Most lecturers said that in the process of changes that took place in their departments, most of teaching staff and departmental staff were in full support for those changes as long as they brought positive results to the improvement process. However, there was one lecturer who responded:

“Most people are supportive of change as long as there are good supporting reasons and clear results come out of the change. However, there are those who resist change just because it is change. I think this happens whenever one implements change in whatever environment. But one needs to be very careful and distinguish between those who are opposing poor changes for good reason and those who are simply scared for their own position as there are many weaknesses in what they do. The second category is usually easy to distinguish as they are those who drive no change themselves and who will be the first to complain about anything and everything... Sometimes, some of their criticism will be valid, but this hides the fact that they generally fail to provide any constructive criticism or accept any changes, except for minor, irrelevant changes that come from themselves, as good. They are often also happy to discuss change endlessly in what turns out to simply put off change. Most people are not quite all this bad (there may be one or two) but there will be few others who exhibit these sorts of traits quite often. Generally, success comes by just pushing ahead with change... but again, care needs to be taken to accept and respond to valid criticism” (A3L2).
Future Directions

Most Australian lecturers responded that the future direction of undergraduate physics teaching and learning practices in Australian universities should focus on students’ needs. For examples:

- **Introduction of specialized units in higher years relevant to current research such as nanotechnology.** Teaching styles need to evolve to meet demands of today's students with reference to student background, abilities and expectations (A1L3).

- **Learning physics is challenging.** These should be two systems: one for students who choose to have their future career in physics-related fields; and the other (easier) for those who want to develop their career unrelated to physics (A2L1).

Some lecturers focused on pedagogy as they responded to the question:

- **I think Peer Instruction helps.** Lecture demonstrations help enormously. Doing labs in synchronization with lectures helps. Giving summaries as revision helps (A2L3).

- **It should remain face to face as much as possible.** I do not think that online courses are engaging and/or a good learning experience (A2L2).

- **Engagement; Lecture demonstration; Excellent research** (A1L2).

7.4.2. Vietnamese lecturers’ perspectives on challenges, changes and directions

Challenges and Changes

The Vietnamese lecturers’ responses concerning challenges and the changes that they had done to improve student quality of learning are summarised as shown in the following passages:

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Changes</th>
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<tbody>
<tr>
<td>Students’ low entry marks</td>
<td>Restructure curriculum</td>
</tr>
<tr>
<td>Students’ lack of ICTs skills and learning skills</td>
<td>Changes to credit point system</td>
</tr>
<tr>
<td>Students’ lack of motivation</td>
<td>Reducing teaching time</td>
</tr>
<tr>
<td>Inadequate infrastructure, lack of facilities, equipment and resources</td>
<td>Changes in teaching approaches and teaching content</td>
</tr>
<tr>
<td>Curriculum does not meet the demand of society</td>
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<tr>
<td>Credit point system does not give enough time to cover the content</td>
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There were four Vietnamese lecturers who responded that one of the challenges of undergraduate physics teaching and learning practices in Vietnam was students’ low entry marks. They felt that the students’ background on mathematics and physics was poor. This situation is similar to the responses from the Australian lecturers. Particularly, one of the lecturers said “in recent years, the university entrance score for physics has dropped down significantly” (V2L2). Another lecturer stressed that “the quality of students coming to study physics becomes lower and lower compared to the past. One of the reasons for that is good students tend to choose hot-career areas to study such as economics, finance and banking...” (V3L1).

Students’ weakness in using ICTs and learning strategies was also referred to by some of the lecturers. For example:

- “We have many students who do not have their own personal computers and some 1st year students who do not know how to use computers or have little knowledge about ICTs. So that is one of obstacles in using ICTs to improve their learning” (V1L1).

- “Most of our first year students bring with them learning methods from secondary schools where they had been passive learners for many years before they go to the university and now it takes time to change that...” (V3L3).

Some of the studied universities reacted to this problem by delivering courses for excellent students with the aim of attracting more quality students to enrol in physics and of producing high quality physics graduate students. “Our university has physics courses for excellent students. These courses use advanced curricula that are used in some U.S universities”, said one lecturer (V1L2). The low quality of current students and incoming students is also a problem for teaching staff. For example, one of the lecturers stressed that “we have to devote our energy and time to address this issue. Particularly, we have to teach carefully and thoroughly so that students can understand physics knowledge at university level” (V3L3).

The problem of students’ lack of engagement in learning was also seen as a challenge in improving physics teaching practices. Although most lecturers had positive
responses on the enthusiasm and motivation for learning of the majority of students, some lecturers stressed the lack of motivation in a minority of students as a teaching issue. The following examples show a perception of some lecturers of a lack of motivation in some students, presenting itself as absenteeism, plagiarism, and surface learning:

- “... Some of them seem too tired when they come to lectures. The number of students absent from lectures seems to increase. Some of the students were even sleeping during lecture time... So we have a process of calling the roll of students at the beginning of lectures and sometimes at the end of lectures as well” (V2L2).

- “The problem of copying exercises, laboratory reports, and homework problems is a serious issue that we need to deal with” (V1L1).

- “... Some students just learn to pass the tests...” (V3L1).

As described in the previous section, all of the Vietnamese lecturers considered the inadequacy of infrastructure and the lack of equipment and resources as discouraging factors in improving their undergraduate teaching practices. Similarly, their responses to the question about challenges they were facing were the lack of teaching and learning facilities, ICTs and resources, especially in undergraduate physics laboratories. These were one of the most challenging features in the process of improving the quality of undergraduate physics teaching practices.

The issue of undergraduate physics curriculum that embraces too many subjects and significant content within subjects was also appraised by some of the lecturers. They stressed that: “I think that although we have changed our curriculum to a credit point system, the current physics curriculum still has excessive content and subjects...”; “compared to what I know from undergraduate physics programs from some U.S universities, most of Vietnamese physics curricula have more subjects... and I think it does not meet the demands of society”. The large number of subjects and amount of content also caused a problem with teaching because according to some lecturers, they did not have enough time to cover all the content.

The biggest changes that all lecturers asserted as an effective way to overcome the challenges and to improve quality of Vietnamese higher education was a switch from the traditional subject-oriented system to a credit point system adopted from some of the
U.S higher education institutions. In the traditional system, all undergraduate physics students had to study the same subjects to gain the BSc PHY degree while in the credit point system, each subject is assigned a certain number of credit points and undergraduate physics students have to earn enough credit points required in the curriculum to gain the degree. This credit point system gives students more freedom in choosing elective subjects and courses from different institutions.

The change in the content and time requirement of physics syllabi in the credit point system was also noted by the lecturers. According to one of the lecturers, “in this new system, the amount of content delivered in each lecture is reduced, so students are required to spend more time on independent learning...”. One of the aims of the credit point system is to promote students’ independent learning and student-centred teaching approaches. For instance, “in comparison to the traditional subject-oriented system, the amount of lecturing time for the subject that I am teaching is reduced by 40% while the content of the subject is not reduced that much. So we are encouraged to used student-centred teaching approaches. Our role now is a kind of instructors or facilitators and students have to be active in their learning process. They are not just sitting there and waiting for lecturers to give whatever knowledge they have”, said one lecturer (V3L1).

Resistance to the Changes

Theoretically speaking, this change to a credit point system would be a successful innovation to the Vietnamese higher education system if it is implemented properly. “However, in reality, most universities do not offer electives and do not assign instructors for them, so credit transfer is not happening among universities... Therefore, even though the curriculum offers electives, since there are only a small number of electives to begin with, electives are actually the same compulsory subjects. These are the reasons why all the students in one curriculum end up taking exactly the same subjects until graduation” (Kamibeppu, 2010, p. 3).

Therefore, in actual teaching and learning practice, the MOET has required all Vietnamese universities to restructure their curricula and courses in a direction of reducing teaching content of courses and contact time and increasing independent learning in students. However, because of the reduction in teaching time required for
subject content, most lecturers stressed that it was difficult to deliver their teaching materials effectively. For example, one lecturer said that “reducing the number of hours for physics teaching from 150 hours (10 credit points) to 60 hours (4 credit points) results in difficulty for lecturers to choose the physics content and methods of teaching”. Consequently, many lecturers responded:

- “I have tried to instruct students to learn independently in the classroom, but sometimes the classroom was in a state of chaos because there was a large number of students and sometimes they did not know what to do... So sometimes I think that there is not much difference to before.” (V3L2).

- “The majority of students still expect lecturers to give them lectures and to write information on the board. They do not want to read by themselves what I tell them to prepare for the next group discussion, so at the time of the discussion, they start reading, so you know that it is not a good kind of learning” (V3L1).

- “I see that the main teaching methods used by many lecturers are still teacher-centred” (V2L2).

Future Directions

The lecturers’ responses to the question about the future directions of undergraduate physics teaching and learning practices in Vietnam are categorised into two different directions. Particularly, some lecturers stressed that undergraduate physics practices in the future should focus on the needs and the demands of society:

- “Move in the direction of training students to meet the demands of society and industries so that the curriculum, physics content, teaching methods, and facilities and resources should be changed to be suitable and flexible to this direction” (V1L1).

- “Follow the demands of society” (V3L2).

Other lecturers focused on restructuring physics curricula, courses and teaching approaches:

- “Should not reduce too much content; should reduce only parts that are not necessary for each major, for instance, students specialising in constructions do not need to study nuclear and particle physics. Lecturers should mainly check the ways students make independent learning” (V3L1).

- “The university should have more subjects in order to have more selective subjects that are suitable to students and also reduce some compulsory social
science subjects that natural science students may not need to learn. That will make students feel comfortable, have confidence and make it suitable for them to learn” (V1L2).

- “Increase self learning and study modes. Increase students’ creativeness” (V2L2).

- “Need to have more time on practice work to help students have better understanding of the physics content taught” (V3L3).

7.4.3. Summary of lecturers’ perspectives on challenges, changes and future directions in both countries

Both the lecturers in the Australian and Vietnamese universities considered the poor mathematical and physics background of students and their lack of motivation as challenges to teaching practices in undergraduate physics. The lack of ICTs and learning skills in Vietnamese students were also a challenge as described by some lecturers. The lack of funding and the high student to teacher ratio were other two challenges reported by most Australian lecturers, whereas the inadequacy of teaching and learning facilities, equipment and resources was a big problem in the Vietnamese universities, according to all Vietnamese lecturers. The undergraduate physics curriculum with a large number of subjects and large amount of content was also considered a big problem in teaching practices in the Vietnamese universities.

In order to address these challenges, the Australian lecturers said that their universities, departments and they had put a lot of effort into creating curricula that meet students’ ability and needs and focus on more vocationally oriented content, putting more teaching materials online, training tutors and demonstrators in teaching skills when supervising students, and encouraging lecturers to use a variety of interactive student-centred teaching approaches. In the process of change, there was no particular resistance to the changes with the interviewees, but one lecturer referred to other staff who were resistant to the change.

On the other hand, all the Vietnamese universities are currently restructuring their undergraduate physics curriculum by adopting a credit point system. The number of subjects and the amount of content in this new curriculum has been reduced noticeably. Lecturers were also encouraged to use interactive student-centred approaches
in their teaching and students were expected to have more independent learning under this curriculum. However, there were quite a number of points of resistance described by some lecturers because the change was not in line with the subjects provided by the departments, subject content, time constraints, and large class sizes. Especially, with the students’ habit of learning which is dependent on the information delivering by lecturers, encouraging student independent learning is a difficult task for most lecturers.

The Australian lecturers’ perspective on future direction of undergraduate physics teaching practices was that undergraduate physics curriculum should be designed to be suitable to the needs of a variety of different students. Similarly, the Vietnamese lecturers also thought that undergraduate physics practices in Vietnam should move to a direction of training students to meet the demands of society and industries.

7.5. Physics education innovators’ opinions on undergraduate physics teaching and learning practices

The previous sections have investigated the opinions of the lecturers who are currently doing research and teaching undergraduate physics at the studied universities. This section investigates the opinions of some physics education innovators in Australia and Vietnam to gain more insight into current undergraduate physics practices and insight into the directions of undergraduate physics practices in both countries. Their opinions are important concerning the current practice of undergraduate physics in Australia and in Vietnam because they have been involved in many studies aiming at improving physics teaching and learning practices.

7.5.1. Australian physics education innovators’ opinions

On Current Undergraduate Physics Teaching and Learning Practice

According to the innovators, current undergraduate physics teaching and learning practices in the Australian universities have strengths and successful features as well as challenges and weaknesses. One of the successful features that most lecturers and education innovators pointed favourably to is the commitment of all department staff to make students more active in their learning process. Most teaching staff from all studied
universities understood that using interactive student-centred teaching approaches was the best way to facilitate student learning. Therefore, according to some innovators, universities had implemented some interactive learning methods such as CUP (Cooperative Understating of Physics), practice software, and challenge problems in the laboratory.

All physics departments encourage teaching staff to use interactive methods in their teaching. For example, one of the innovators talked about the innovations that the department of physics had successfully implemented in teaching practices such as:

- “We try to integrate the learning in laboratories and the learning in lectures and tutorials and try to make sure that all of those pieces work together... Try to do a good job of training our tutors and demonstrators and try to help tutors understand some aspects of physics education research too... I have been implementing some of the things that Eric Mazur does... we are limited in a sense that we do need to have a lecture format but we do want those to be interactive as possible... we have quite a lot of having students think in the lectures about what is being learnt. It might be multiple choice questions, and it might be them talking to the person next to them and responding to a question with an answer, it might be by having a demonstration and asking students to predict what they think they will see, doing the demonstration and then reflecting and talking to the next person about why, what they saw, was it exactly what they were expected...” (A2I1).

Another successful feature that some of the innovators and heads of departments of physics highly valued is that they provided more contemporary physics courses such as nanotechnology, space science, and biomedical physics and flexible curriculum that were suitable to all students and accommodated students’ needs. For example,

“... We have a large number of students... It means that some of the students come in from the school with very strong physics and maths background, and some students come in from the school not having done any physics in year 11 or 12, and there whole lot of students that they had done physics and maths at school... their maths is solid but not outstanding. So what we do is we offer three different subjects: one is an advanced subject that is for those who had strong physics and maths background; an introductory subject at first year level for people who had not done physics in year 12 or did physics but really struggle..., and then there is the subject for the rest of them...” (A1I1).

However, some innovators also argued that the teaching and learning practices in undergraduate physics in three Australian universities still have many challenges and
problems. Some of problems are serious and need to be addressed and changed in order to improve student learning quality in physics. These challenges and problems with undergraduate physics teaching practices in these universities can be identified as: the neglect of teaching in favour of doing research, the dominance of using teacher-centred learning approaches in teaching, the exam-based learning strategies among students, the high ratio of students to staff, and the lack of funding.

As described in previous sections, most of the studied lecturers in the Australian universities considered that teaching and doing research were both important. However, there were still lecturers who stressed that their universities employed them totally based on their research ability. The preference for doing research over teaching in Australian universities was considered a fundamental problem with not only undergraduate physics teaching and learning practices but also with other disciplines. For example,

“...The fundamental problem with undergraduate physics teaching in this country is still that as it is with a lot of undergraduate teaching in sciences and other faculties not enough people take teaching seriously enough, not enough people understand or accept that there are things to be learnt about teaching, learning and assessment that will improve the quality of student learning. So people who are concerned about learning and who work hard to improve student learning are still commonly across the whole range of subject departments are seen as being poor academics who are not concentrating on basic research. That is a fundamental problem that has been a serious issue with university teaching for a very long time and it is still present” (A3I2).

The second issue associated with undergraduate physics teaching and learning practices in the Australian universities is about teaching approaches that the lecturers use in the classroom. This study has shown that in most observed lectures, lecturers still used traditional teacher-centred learning approach in their teaching and this was also clarified by some of the lecturers. It is again addressed by one of the innovators:

“...You are not funded to teach in groups of any less than a hundred and something... How do you handle two hundred people in one room and not make it teacher-centred? That is actually very difficult to do. I do not know many professional educators who can do that. I do not know many people in the faculty of education ... who can do that...” (A1I1).

The teacher-centred teaching approach in lectures is also associated with the high ratio of student to teacher and the lack of funding. Particularly, in all the studied
universities, the number of students in a first year lecture was usually over one hundred. This problem is again associated with the lack of funding. For example, one innovator stressed that “if you do not want to run lectures, you need more people. If instead of one hour lectures, you are going to give one hour workshops, you need more people. Instead of having one academic for two hundred students, you will need one academic for ideally every twenty students or every forty students. Nobody can afford that; they can barely afford to cover the lectures” (A1I1).

Another problem of undergraduate physics teaching and learning practices in the Australian universities is student learning strategies. As described in previous sections, some lecturers stressed that many students did not know how to learn physics and did not have the ability to think critically, but tried to remember facts and equations. They also stressed that some students learnt physics with the purpose of passing examinations. Therefore, many students considered past exam papers as the guidance in their learning, and this problem was also referred to by many students as described in chapter 4. According to one innovator, this student learning problem in undergraduate teaching of physics has lasted for a long time and it may be the result of teaching and learning policy at the departmental level. The following extract is of this innovator:

“The single most obvious indicator that things have not changed nearly as far or nearly as quickly as I had spent a lot of my professional life trying to foster the ways in which assessment occurs. Universities often talk about creating independent learners... that is a good thing. They have no understanding of what schools are doing to try to do this of course. They assume that students will be totally ignorant, and they need somehow to fix the problem that the schools created. But the most common approach to create independent learners is to remove the support structure that they think somehow rather inappropriate at the university. So you get some lecturers who will say I am available to see students between 10 and 12 on Monday morning, but do not come at any another time. They think that they would justify it by saying students need to stand on their own feet... The problem is the absence of any help in become an independent learner, most students then fall back on other support structures: lecture notes and exam papers. So the exam paper drives what they learn and how they learn and whether or not they see the purpose ... So assessment drives how they approach their learning” (A3I2).
On Future Directions

The education innovators tended to have similar perspectives on future directions for undergraduate physics teaching and learning practices. Particularly, most innovators stressed that in order to improve the quality of student learning, undergraduate physics teaching and learning practices should move towards totally interactive student-centred learning classrooms. As one innovator said “lecturing is not teaching. Lecturing is at one level is form of reading a textbook aloud... there is a time the lecture is appropriate for sorts of reasons but as the norm it is a waste of public money” (A3I2).

The view of the innovators is also the view of most lecturers as described in previous sections, that constructivist teaching approaches should be the main approaches in teaching undergraduate physics in the future. The following extract is an example from an innovator who talked about the methods of engaging students in their learning:

“I need to go even further with making sure that techniques of teaching are interactive and that students engage continually in learning. I think about having students write about physics but not just solving problems and making sure that they are using the language of physics in their writing and speaking and that they are able to explain physics... Having a strategy where you ask a question then you get them to talk to each other and try to convince other students why they are right and the others are wrong. It is forcing students to be able to think deeply enough to be able to defend their answers, and the same thing happens in the labs and tutorials...” (A2I1).

7.5.2. Vietnamese physics education innovators’ opinions

The opinions from Vietnamese innovators were collected during a 7th national conference on physics held in Hanoi on 8th – 12th November 2010. This conference was an opportunity for physics teaching staff from most Vietnamese higher education institutions to attend and exchange their experience in teaching tertiary physics. Many physics educators who were physics education researchers and innovators, physics departmental administrators and leading physicists in Vietnamese physics institutions attended the conference. These are equivalent to the physics innovators interviewed in Australia. At this conference, most physics educators and innovators were involved in discussions about the challenges and changes that physics education at tertiary level is facing and about the strategic plan for physics development in Vietnam to the year 2020.
The data for this study were gathered from detailed field notes taken at the public discussions at the conference and the papers presenting at the conference.

On Current Undergraduate Physics Teaching and Learning Practice

As described in previous sections, in recent years, the curriculum of most subjects and learning areas in Vietnamese higher education institutions has been restructured. The move towards a credit point system to replace the traditional subject-oriented system has resulted in changes in most aspects of the higher education sector. The reduction of the number of subjects, the amount of content, and the number of face to face contact hours has forced lecturers to change their teaching practice in order to make student learning effective. Since the day that the new credit point system was implemented in Vietnamese tertiary curricula, there have been many debates and discussions among Vietnamese teachers and educators about the effectiveness of the new system and about how their teaching practices should change to utilise the strength of this new system in training students effectively.

According to most Vietnamese physics educators, the demand for physics graduate students in Vietnam in the next few years will be high for a number of reasons: Vietnam is on its way to become a modernised and industrialised country; Vietnam needs physics experts and workers to build and work in its first nuclear electric power plan; and many higher education institutions are searching for physics teaching staff. Therefore, departments of physics in Vietnamese higher institutions have the opportunity to train many physics students, but they also have the challenge of producing quality graduate students to meet the demands of society.

The most challenging factor in undergraduate physics teaching and learning practices, according to most Vietnamese physics lecturers and educators, is to ensure the quality of student learning in the new credit point system. In order to implement successfully this new credit point system in teaching undergraduate physics, physics curricula need to be restructured to have more elective subjects and less content. In recent undergraduate physics teaching, because of the significant reduction in the amount of face to face contact time while the subject content has only been reduced
slightly, lecturers have to change their teaching approach to foster independent learning in students.

Other problems that most Vietnamese physics educators and innovators discussed were the lack of teaching facilities, equipment and resources and the low qualifications of teaching staff in most departments of physics in Vietnam. Therefore, the government needs to invest more to modernise teaching and learning infrastructure. Vietnamese universities also need to develop standards for their teaching staff to ensure all have good qualifications for teaching undergraduate physics students.

On Future Directions

The advantage of undergraduate physics teaching and learning practices in most Vietnamese universities is the quality of students coming to study physics. Hence, most physics educators and innovators stressed that physics courses for excellent students need to be fostered in most universities to train high quality graduate students. At the same time, several excellent physics centres need to be formed across the country in order to encourage physicists and physics teachers to do research and to contribute their knowledge to the development of physics in Vietnam.

One of the physics innovators said that “in the future, in order to improve the quality of physics teaching, curricula need to be up to date, and physics educators need to build a set of textbooks that are suited to the needs of each type of students. The content of physics curricula should have fewer subjects and increase the number of elective subjects”.

7.6. Chapter summary

This chapter has investigated opinions of physics lecturers in both countries on undergraduate physics teaching and learning practices as well as their opinions on changes, challenges, and future directions of physics teaching.

The lecturers in both countries believed that students learned physics effectively when lecturers applied interactive student-centred teaching approaches in the classroom. They also had similar opinions on the ineffectiveness of traditional teacher-centred teaching approaches in helping students understand physics. However, in actual
practices in lectures, tutorials, and laboratories, the teaching and learning approaches in the Vietnamese universities were mostly traditional teacher-centred teaching and learning. On the other hand, the Australian lecturers incorporated interactive teaching approaches, often by using the availability of ICTs and resources in their teaching, especially in tutorial sessions.

Similarly, most lecturers in the Australian and Vietnamese universities had the view that both teaching and doing research were important and the link between research and teaching were helpful for their professional development and for effective teaching. However, because the main responsibility of the Australian lecturers is doing research, the quality and output of their research exceeds that of their Vietnamese counterparts. They also brought their research skills, cutting-edge knowledge, and applications into their classrooms to show students the meaning of physics theories that they are learning. In contrast, because the Vietnamese lecturers’ main duty was delivering lectures, the research they undertook was often on improving their teaching. Therefore, most of their research topics arose from their teaching experiences in the classroom and the findings were applied back to the classroom.

The successful features associated with teaching in departments of physics and universities that the Vietnamese lecturers valued were the enthusiasm and strong physics and pedagogical knowledge of teaching staff and the strong background on physics and mathematics of undergraduate physics students. In addition to these two features, the Australian lecturers also viewed the quality of teaching and learning facilities and resources and their undergraduate physics curriculum and assessment processes as successful features supporting their physics teaching practices.

The challenging factors that the Vietnamese lecturers considered as affecting their teaching practices were the inadequacy of teaching and learning facilities and resources and the large number of subjects and the large amount of content in the physics curriculum. Some of the Australian lecturers viewed students’ poor background in physics and mathematics, a lack of funding and a high student to teacher ratio as constraints affecting the quality of physics teaching practices at their departments.
In order to address these challenges, the Australian lecturers said that the physics curriculum should be designed to be suitable to students’ ability and needs and to focus on more vocationally relevant knowledge. Most lecturers and innovators agreed that undergraduate physics in Australian universities should move towards a direction of teaching constructively by using interactive student-centred learning approaches in the classroom.

The Vietnamese lecturers and innovators also stressed that undergraduate physics practices in Vietnam should move in a direction of training students to meet the demands of society and industries. Some of the innovators also supported the idea of training high quality students and opening several elite specialist physics centres. In addition, the Vietnamese universities have been restructuring their undergraduate physics curriculum by adapting the credit point system, which reduces the number of subjects and the amount of content and requires lecturers to use interactive student-centred approaches in their teaching in order to encourage students in more independent learning.

In response to guidelines and support from the departments and universities, the Australian lecturers had more freedom than their Vietnamese counterparts in choosing or modifying subject content and in choosing methods of assessment. Some of the Vietnamese lecturers said that they had to strictly follow the guidelines set out in subjects’ syllabi in term of content and time used to teach, while some of the Australian lecturers responded that they were able to choose what they teach as long as it yielded student learning outcomes set out in subject handbooks. Most lecturers in both countries answered that they were satisfied with the support provided by their departments and universities for their professional development.

The Australian innovators viewed that current teaching and learning practices in undergraduate physics had some successful features such as the commitment of physics staff in encouraging student active learning and the wide range of physics courses and curricula to suit students’ needs. Nevertheless, they also articulated a number of problems associated with undergraduate physics teaching in Australian universities. These problems are: the neglect of teaching in favour of doing research, the dominance of teacher-centred learning approaches in teaching, exam-based learning strategies
among students, the high ratio of students to staff, and the lack of funding. In Vietnam, most physics education innovators stressed that the most challenging factors in undergraduate physics teaching and learning practices were ensuring the quality of student learning in the new credit point system and the lack of teaching facilities, equipment and resources, and the low qualification of teaching staff in most departments of physics in Vietnam.
Chapter 8. Conclusions and Implications for Undergraduate Physics Practices in Australia and Vietnam

A major aim of this research was to investigate the differences and similarities in current teaching and learning of undergraduate physics between three Australian universities and three Vietnamese universities. Another main aim was to investigate changes, the drivers for the changes and future directions of tertiary physics teaching and learning practices in these universities in both countries. These aims were fulfilled in this research study. This study has generated a significant number of findings about differences and similarities in undergraduate physics teaching and learning practices between the Australian universities and the Vietnamese universities, and the contextual factors underpinning these.

Particularly, the study found that notwithstanding some similarities, the teaching and learning of undergraduate physics in three Vietnamese universities and three Australian universities is significantly different in many aspects of practice. This is despite the fact that physics is widely considered as a fundamental science such that the content of theoretical and experimental physics courses at an undergraduate level tends to be quite standard internationally, and that physics knowledge taught at university level has not changed much the last few decades. The differences in undergraduate teaching and learning of physics in particular and of other university courses in general arise mainly from differences in education systems, cultures, expectations, the views of quality and knowledge, the state of the respective economies, and the school infrastructures between the two countries.

This final chapter collects different threads of the investigations into teaching and learning practices in undergraduate physics from the Australian and the Vietnamese universities. It summarises the findings and draws them together. The findings show some strength and weaknesses in the undergraduate physics practices in both the Australian and Vietnamese universities. These findings are very important for informing further improvement in teaching and learning of undergraduate physics in these universities as well as teaching physics at tertiary level in the two countries in general. The following sections are presented within this chapter:
1. Commentary on the major differences and similarities in: (i) the physics content of subjects required for the BSc PHY degree, (ii) teaching and learning strategies in lectures, tutorials and laboratories, and (iii) infrastructure, facilities and resources of the current undergraduate physics teaching and learning practices between the Australian universities and the Vietnamese universities.

2. Lecturers’ beliefs in effective teaching and learning practices, the changes and future directions of undergraduate physics and the coherence underpinning the elements.

3. Implications for undergraduate physics teaching and learning in the Australian and Vietnamese universities and prospects for change in physics education practices.

8.1. Differences and similarities in undergraduate physics practices

This section will summarise the major differences and similarities in undergraduate physics teaching and learning practices between the universities in Australia and the universities in Vietnam and relates these to current debates in Vietnam about the low quality of tertiary graduate students.

8.1.1. Differences and similarities in the content of physics knowledge

The differences in undergraduate physics practices partially resulted from the differences in physics practices in secondary school levels between the two countries. Particularly, the prerequisites of the BSc PHY degree in the Vietnamese universities are seven years of secondary school physics with the content of physics cover all range of physics knowledge and high level of mathematics. Whereas, the prerequisites of the same degree in the Australian universities are two years of secondary school physics (year 11 and year 12) at time physics is a separate subject from other science subjects. Therefore, it can be presumed that Vietnamese students have greater content preparation for learning physics at tertiary level than their Australian counterparts.

However, although incoming undergraduate physics students in Vietnamese universities have greater physics content preparation than their Australian peers, the
preparation for other important generic skills such as practical skills, communicative skills, thinking skills and cooperative skills of the Vietnamese students may be argued to be at a lower level compared to the Australian students. There are several reasons for this contradiction, in which teaching and learning approaches in the classroom at secondary school level are possibly the main reason. Particularly, the Vietnamese students have to learn almost all of physics topics and other subjects in textbook-centred secondary schools without much practical work and the integration of everyday life phenomena (Ng and Nguyen, 2006). In contrast, Australian students have opportunities to explore physics knowledge via science topics related to everyday life contexts. At year 11 and year 12 Australian students learn fewer physics topics compared to Vietnamese students but they have a considerable amount of laboratory work and real life applications.

The issue of too much knowledge and the methods of teaching that focus on physics content rather than students’ learning outcomes are subjects of current debate among Vietnamese educators, in which a vice chancellor of a famous university in Vietnam suggests that the general education in Vietnam should be nine years instead of twelve years as in the Vietnamese current education system (Chung, 2013). Their opinions on teaching and learning practices at secondary school levels are broadly consistent with what exists currently in Australian secondary schools. Although this study did not focus on secondary school physics, it is argued that the methods of teaching of core physics knowledge related to students’ everyday life phenomena should be highly encouraged in secondary school levels in Vietnam.

There is a similar problem raised concerning the large number of subjects and topics that students have to learn to gain a bachelor degree in tertiary education in Vietnam. In comparison, to have the same bachelor degree in physics, the Vietnamese students have to complete 28 subjects and nearly 1,000 hours in face-to-face contact time more than their Australian peers. Some of the Vietnamese students in the interviews stressed that the large number of subjects that they had to learn often resulted in them not having enough time to learn a specific subject thoroughly so that they usually left it until examination periods at the end of semesters. Some of the students
also described that they felt very tired and asleep in the classroom because they had to attend multiple lectures daily.

Under the pressure of success in examinations, too much knowledge to remember might lead to rote learning strategies in students. It is also one of the main reasons that create the problem of cheating by using forbidden learning materials at the test time, which was very serious at all levels of the Vietnamese education system. As a result, having a reasonable number of subjects that are necessary to the students’ areas of learning as in the Australian universities’ BSc PHY degrees is arguably a productive way forward for improving undergraduate physics teaching and learning practices in the Vietnamese universities.

The content of physics subjects in the Vietnamese universities also embraced a lot more theoretical topics and mathematical derivations than the requirements of the subject content in the Australian universities. This issue was also reflected in the examination papers, in which all of the Australian universities provided most of physics formulae and mathematical derivations that were related to physics knowledge of the tests while none of the Vietnamese universities did but required their students to remember and derive needed formulae. This problem was also observed in lectures in the Vietnamese universities where lecturers focused mainly on physics theoretical knowledge and spent a lot of time on deriving multiple mathematical expressions.

Those problems in teaching practices of physics possibly lead to a current situation in Vietnam that most Vietnamese graduate students have to be re-trained by employers because they do not have skills ready to work. The issue of having good theoretical knowledge of a discipline but lacking generic skills necessary for the workplace has long been a topic of debate in most educational conferences in Vietnam. For example, in the conference on “Giải pháp nâng cao chất lượng đào tạo nguồn lực trình độ đại học” (Solutions of Improving the Quality of Higher Education Graduate Labour Force), Mr Phan Thanh Binh – the president of Nhan Viet Management Group – said that according to a survey conducted over 500 companies and corporations in Ho Chi Minh city, 94% of graduate students had to be re-trained to meet the demands of those employers (Anh, 2011). In 2007, Intel Corporation in Vietnam had a test for 2,000
graduate students from top five universities in Ho Chi Minh city but only 90 students satisfied over 60% requirements of the test (Huong, 2008).

In the Australian universities, the lectures did not emphasis much on mathematical manipulations but on conceptual understanding of physics and its applications. Nonetheless, some of the Australian lecturers stressed that the methods of teaching physics that neglected mathematical derivations, especially in modern physics subjects such as quantum mechanics did not help students in understanding of physics. Certainly, at higher levels of physics such as modern physics students’ strong mathematical skills become very important in physics learning.

There is debate also in Australia about the appropriate content of tertiary physics. This study has revealed that some of the Australian lecturers and innovators did criticise the way of physics teaching at secondary school level and the beginning of tertiary courses in preparing mathematics for students in tertiary physics courses. Particularly, these lecturers stressed that students should be better prepared to have good mathematical knowledge in order to learn physics effectively. According to Marginson, Tytler, Freeman and Roberts (2013), there is a worrying trend in less students doing high level mathematics in Australian secondary schools. Therefore, besides methods of teaching that place emphasis on meanings of physics and real life applications, it is argued to be important and necessary for secondary school and tertiary physics teachers to recognise the need of improving mathematics for students who would prefer to learn physics and science courses in the future.

Much of the content of undergraduate physics curricula in the Australian universities, as stated by some lecturers, was designed based on the strengths of the research in their physics departments. Physics curricula and physics courses mainly focused on the basic knowledge of fundamental physics subjects as stated in objectives of these courses. In contrast, physics curricula and courses provided in the Vietnamese universities followed curriculum standards and guidelines from the MOET and must embrace political and moral subjects. Therefore, in comparison, the undergraduate physics curricula provided in the Australian universities are directed more towards physics that was available in their physics research centres, often of an applied nature, and the needs for graduates who possess fundamental physics knowledge. On the other
hand, the Vietnamese universities seem to train graduates who have common qualities such as physics knowledge, ethical and moral behaviour, and political ideology as stated in Vietnamese higher education laws.

8.1.2. The differences and similarities in teaching and learning approaches

The quality of students’ learning depends on many factors, in which good teaching and good learning strategies are considered the most important aspects of improving student performance (Schacter & Thum, 2004). This study has investigated both lecturers’ teaching approaches and students’ learning strategies in lectures, tutorials and laboratories by observing teaching and learning activities, and surveying and interviewing the lecturers and the students.

In lectures, the main teaching approach of the lecturers in both countries was similar in that most of them employed teacher-centred methods of teaching, in which the main activities in the lectures were lecturers’ presentations. For example, the Vietnamese lecturers in observed lectures used an average of 84.3% of one hour lecture time for their presentations compared to 73.63% for the Australian lecturers while the average time that the students were directly involved in learning activities were 5.17% and 4.93% for the Vietnamese and Australian students respectively. These teacher-centred teaching approaches in physics teaching have been profoundly studied by educational researchers and most of the findings indicate that traditional teacher-centred teaching and learning approaches are ineffective in helping students to develop a more scientific view and conceptual understanding of physics.

This study has revealed that most of the physics lecturers in both countries were very aware of the effectiveness of interactive student-centred teaching approaches that drew the students into more active roles in their learning. Most lecturers in both countries described that they had tried to shift their teaching approaches towards more student-centred modes. However, the lecturers in both countries and some of physics education innovators in Australia admitted that it was difficult to implement active student-centred teaching and learning approaches in the classroom because of the necessity if large classes due to lack of funding.
However, as observed in lectures, there were differences in teaching approaches that the lecturers employed in their teaching between the Australian lecturers and the Vietnamese lecturers. The Vietnamese lecturers extensively used traditional chalk and talk to present loads of physics content to the students. The use of traditional methods of physics teaching in the Vietnamese universities is due to many reasons, in which the lack of teaching and learning facilities and resources, the large number of subjects and the large amount of content, the culture of education, and the lack of pedagogical knowledge of teaching staff are probably the main ones. In this study, most of the Vietnamese lecturers described inadequate teaching and learning facilities and resources that affected the quality of student learning. In contrast, the Australian lecturers did not go into details of the content because students had their printed handout notes. As a result, the Australian lecturers had more time to focus on presenting main points and the application of the physics knowledge instead of spending time on writing all the lecture information on the board.

In the Australian lectures, access to technology had a huge effect on the methods of delivering physics knowledge to the students and students’ learning strategies in the lecturers compared to Vietnam. Particularly, most Australian lectures were integrated with physics graphics, diagrams, animations and simulations in PowerPoint slides. Australian students were able to access learning materials, guidelines and supports via the Internet. Digital tools such as computers, audio and visual tools also made the difference in students’ learning strategies in classrooms between the two countries because technology shifted the ways the students acquired their knowledge in the lectures, tutorials and laboratories. In the Vietnamese universities, the students’ main activities were to concentrate on listening and duplicating into their notebooks the information written on the blackboards by the lecturers. The Australian students, however, were more relaxed because their main activities in the lectures were to watch and annotate their printed lecture notes with further information explained by the lecturers.

The availability of electronic communication facilities in the Australian universities also varies the ways the knowledge is delivered. The source of learning materials is no longer limited to lecturers’ knowledge and textbooks and neither is the
students’ acquisition of knowledge. In the digital learning environment, the Australian students were able to access necessary knowledge and to communicate and discuss with their peers and instructors outside the boundary of the classrooms. They were, for example, able to access online lectures, tutorials and pre-lab exercises, to download learning materials, and to exchange their understandings of the physics knowledge in online learning forums. These ways of teaching and learning enabled students to control their own learning compared to their Vietnamese counterparts.

In tutorials, there was a significant difference in the way the tutorials operated, between the Vietnamese and the Australian universities. All the Vietnamese undergraduate tutorials followed the same format and process as the students were asked to come up to the blackboards to solve their homework problems in front of the whole class. In contrast, all of the Australian tutorial sessions were divided into small group tutorials with about fifteen students and a tutor in each session. Certainly, it can be said that the tutorial sessions in the Australian universities compensate for the large number of students in the lectures. On the other hand, it was hardly to distinguish the tutorial sessions from the lectures in the Vietnamese universities regarding to the classroom setting and size.

There was a collaborative learning environment in the undergraduate physics tutorial sessions in the Australian universities, where the students and the tutors aimed not only at actively solving the tutorial problems but also at understanding the physics knowledge that they had learnt in the lectures. In these tutorials with small number of students, all of the students were more likely to have opportunities to participate in solving their homework problems, to express their understandings of physics knowledge and to get timely feedback from the tutors. As a result, most of the Australian students valued the collaborative work in tutorials and considered tutorials as helpful features in their physics learning.

In the Vietnamese universities, however, the students experienced a public problem solving environment, where from the interview evidence, it seemed that many the students were afraid of losing face in front of the whole classrooms if they were not able to solve homework problems. Furthermore, with a large number of students and the blackboard problem solving methods, it can be argued that the students did not have
many opportunities to work and discuss in groups in order to express and get feedback on their understanding of the physics knowledge learnt.

The large number of students in the Vietnamese tutorials is again mainly hindered by the inadequacies of infrastructure and the lack of funding in higher education from the Vietnamese government. Particularly, in order to have small numbers of students as in the Australian tutorials, it would be necessary to have the availability of classrooms to divide those large Vietnamese tutorials into smaller ones. In addition, the more important factor is the universities must have enough funding to pay for the increase in the number of tutors to run many different small tutorial sessions in place of the larger ones. In Australia this is made possible through the employment of sessional staff such as higher degree students, whereas in Vietnam all teachers are staff members.

In undergraduate physics laboratories in the universities in the two countries, the basic teaching and learning experimental activities were very much similar. It seems that laboratory work is quite standard internationally. The noticeable differences lay in the laboratory equipment and facilities and the connection between the experiments and physics knowledge delivered in the lectures. In fact, all of the Australian universities’ undergraduate physics laboratories were well equipped with modern instruments and had comfortable spaces compared to the laboratories in the Vietnamese universities. Besides, most of the Australian experiments, especially the experiments in later years of the degree, were connected to research strengths of each university while most of the experiments in the Vietnamese physics laboratories were similar because of the commonly standard physics curriculum imposed by the MOET.

As in the lectures, the modern experimental equipment with digital tools such as computers, educational software and printers also created substantial differences in students’ learning methods in laboratories between the Vietnamese universities and the Australian universities. Particularly, the Australian students manipulated the data of many experiments directly at the laboratories using computer software such as Microsoft Excel to generate graphs and the experimental results. The use of computers was more likely to simplify manipulations of data and formulae so that it gave the students more time for understanding the experiments. It also helped the students in analysing their experimental data more quickly and accurately, especially in calculating variables from
the experimental results. Additionally, the use of electronic tools by the Australian students in laboratories authentically represented physics research methods that physics researchers use in their everyday activities and was similar to the tasks in contemporary workplaces. Therefore, it would be very helpful for the students in their future careers as researchers or any physics related professionals.

In contrast, the Vietnamese students calculated and sketched the experimental data and graphs manually in most of their experiments. Certainly, it took more time for the students to manipulate the data and it reduced the range of possible analysis. The laboratory workspaces in the Vietnamese universities were small with minimal resources, which created a less comfortable learning environment for the students than in the Australian universities. Furthermore, the students in most of the Vietnamese universities were required to undergo oral tests prior to the experimental sessions to check their preparation for the experiments that they were going to perform. As indicated by some interviewed students, this process was quite stressful to them because if they did not prepare the experiments well they would not be allowed to do the experiments. In Australian universities, instead of doing the oral tests, the students had their pre-lab exercises by answering online questions and these exercises’ marks were counted towards the final marks.

The differences in teaching approaches in lectures, tutorials and laboratories were also reflected in the students’ responses to the question on their learning strategies. In particular, the data showed that many Vietnamese students seemed to follow a routine way of learning by concentrating on listening and copying all information that the lecturers wrote on blackboards. In the process of learning, the students experienced not many opportunities of working in groups and discussing with other peers and the instructors. These learning strategies further support the traditional teacher-centred teaching approaches in the Vietnamese universities. The Australian students, however, valued group work, especially in the tutorials. Working in small groups definitely gave the students more opportunities to engage in active learning by discussing and expressing their understanding of the knowledge learnt to other peers.

In brief, the teaching and learning approaches that the lecturers and the students used in their physics lectures, tutorials and laboratory work in the Vietnamese and
Australian universities had significant differences. The inadequate infrastructure, the lack of teaching and learning facilities and resources, the crowded undergraduate physics curricula and subject content and the authoritarian culture were identified as factors that contributed to the teacher-centred approaches of undergraduate physics teaching in the Vietnamese universities. Most of the teaching and learning activities in these Vietnamese universities revolved around the lecturers and the learners were the passive recipients of lecturers’ knowledge via transmitting chalk-and-talk methods.

In Australia, with the advanced audio-visual equipment and multimedia communication facilities in the studied universities, the lecturers were able to implement teaching and learning activities that assisted the students in learning on their own initiative. Student group work and group discussion were also encouraged, especially in tutorial sessions with the aim of facilitating a collaborative learning environment among the students. Therefore, the students in these universities, in comparison with the Vietnamese students, had more control of their learning and were less dependent on their instructors.

8.1.3. The differences and similarities in teaching and learning infrastructure and resources

The observation showed that the physical infrastructure of the Vietnamese universities and of the departments of physics in these Vietnamese universities was well below the standard of the Australian universities. For examples, the physics laboratories and the libraries in the Vietnamese universities, the two most important venues for the students to effectively learn physics, were comparatively less than adequate both in spaces and teaching and learning equipment and resources. Most of the Vietnamese lecturers and the students also responded that the inadequacy of teaching and learning facilities and resources was the constraint that prevented them from improving physics teaching and learning practices.

The issue of libraries not having sufficient spaces, resources and up-to-date teaching and learning materials, especially digital tools and online teaching and learning sources is one of problems debated in Vietnamese education. There was also a similar problem in the Vietnamese universities’ undergraduate physics laboratories. The lack of
spaces and old equipment were observed in the physics laboratories in these universities. Therefore, the students did not have opportunity to work with modern equipment and advanced experiments. This is potentially a big disadvantage for the students, limiting their gaining of technical knowledge and skills required in modern workplaces.

Foremost, the lack of integration of digital technologies into teaching and learning practices in the Vietnamese universities emerged as a critically important issue. Although ICTs were implemented in teaching and learning in these universities, they were not adequately installed or properly used to enhance teaching and learning physics. Particularly, all of the observed lecture venues in these universities did not have adequate multi-media facilities in order to teach electronically. Online lectures, online tutorials, and online interactive teaching and learning activities were uncommon.

As discussed in the previous sections, the availability of digital teaching and learning facilities is one of the major differences that affect the ways of teaching and learning practices in the universities in the two countries. In the Australia, the physical infrastructure of the studied universities such as buildings had not changed much for several decades but the pedagogy had changed to match the change of ICT access. These Australian universities had an integrated digital teaching and learning environment where teaching staff and students had opportunities to experience a range of ICTs.

Particularly, multimedia lectures, online lectures, online tutorials, online pre-lab exercises, and especially online resources available in the Australian universities opened up a different learning environment where the students were able to access to the physics knowledge and to find the knowledge’s applications at anytime and anywhere. ICTs provided a motivating learning environment in which they were be able to learn on their own initiative and actively engage in their learning. Whereas, the lack of that facility in the Vietnamese universities restricted activities of teaching and learning practices to the classroom settings under the guidance of the lecturers. The dominance of teacher-centred teaching approaches in the Vietnamese universities reduced students’ opportunities to engage in active learning and arguably increased rote learning methods used by the Vietnamese students.
8.2. Lecturers’ beliefs in effective practices, the changes and future directions and the coherence underpinning the elements

Most of the lecturers in the universities in both countries believed that creating a motivating teaching and learning environment whereby the students were actively engaged in learning activities would help students learn physics and other disciplines effectively. They stressed that effective teaching approaches in physics teaching should substantially include group work and group discussions where students were the main participants in the process of the teaching practice. Their pedagogic beliefs are of contemporary constructivist perspectives. The constructivist theory of learning states that students are active in constructing the knowledge on their own based on their existing experiences through a process of developing and testing new knowledge. In other words, the effective way to help students comprehensively understand their learning is to directly and actively involve them in learning activities in the classroom.

In Australia, the majority of the Australian lecturers valued students’ ability to think critically and to understand conceptual knowledge rather than their ability to memorise physics principles, laws and formulae and to grasp procedural knowledge. Therefore, in most of their teaching in the lectures, they focused much on main points of the physics knowledge of lectures but not on mathematics and physics formulae. Additionally, tutorial and laboratory sessions could be considered as a supplement to the teacher-centred lectures in term of students’ group work activities. Moreover, as discussed in the previous section, with the support of the available ICTs for teaching and learning in the Australian universities the Australian students had opportunities to experience an active learning environment consistent with constructivist principles.

Similarly, most of the Vietnamese lecturers believed that effective methods of teaching should encourage active participation of students in classroom by asking questions, giving examples and solving problems. However, most of the observed lectures and tutorials in the Vietnamese universities were still very much traditional teaching methods. The lecturers still used chalk and talk to present their lectures. Most of the lectures also focused on theoretical knowledge of physics and manipulations of mathematics but lacked the integration of applied knowledge of physics. This kind of
teaching was also described by many Vietnamese students as one of the discouraging factors in their learning of physics in their departments.

Many possible reasons for the dominance of traditional teaching and learning approaches in the Vietnamese classroom have been identified such as the large amount of content and curriculum, the culture of education, the lack of infrastructure and resources, the large number of students, and the inadequate integration of ICTs. With the lack of these teaching and learning conditions and the existence of the problems, it was possibly very difficult for the lecturers and the universities to implement a constructivist learning environment in physics departments and in these universities in general.

The lecturers’ beliefs in effective practices, the changes and future directions in both countries are coherent with the views of the country’s physics education innovators. As described in Chapter 7, the Australian innovators support the move towards active learning and physics curricula and courses that suit students’ needs. They also stressed that the problems of neglecting teaching in favour of doing research, the dominance of teacher-centred learning, exam-based learning strategies, the high ratio of students to staff, and the lack of funding were those that needed to be addressed to raise the quality of undergraduate physics education in Australia. The Vietnamese physics education innovators also identified the same problems associated with undergraduate physics practices that concerned the lecturers. These problems are the lack of teaching facilities, equipment and resources, the low qualification of teaching staff in most departments of physics in Vietnam and effective teaching and learning approaches needed for the new credit point system.

8.3. Conditions and prospects for change in undergraduate physics teaching

This study has revealed that in both countries there is a belief in active student-centred learning and in Vietnam this is strongly reflected in official policy directions and the opinions of the lecturers and innovators. However, the findings of this study show that the move towards interactive student-centred teaching and learning approaches in the Australian universities seems to be further ahead compared to the Vietnamese universities. There are a number of factors and conditions underpinning the practices in Australian universities that contribute to this. This section will summarise the findings
to identify the conditions that the Australian universities have effectively utilised to have students more actively participate in their learning processes compared to the practices in the Vietnamese universities. This section will also collect different threads of the investigations to pinpoint the prospects for change in undergraduate physics teaching and learning practices in both countries towards more student-centred teaching and learning practices and the likely lessons for Vietnam from the Australian universities’ experience.

8.3.1. The commitment in Australia to graduate skills compared to the moral and social emphasis in Vietnam

Realising the importance of developing generic skills in students, in recent years, the Australian higher education sector has been moving towards a direction that focuses on graduate skills. There are several reasons for this movement, in which the demand of employers for graduates who possess not only disciplinary knowledge but also a range of skills and capabilities such as communication skills, problem solving skills and analytical skills is one of the main reasons. For example, the following factors are indentified by the University of Tasmania as the reasons for an increased focus on generic graduate skills:

- It is no longer sufficient for graduates to simply acquire disciplinary knowledge to guarantee them a job at the completion of their degree.
- Increasingly, employers expect their recruits to be able to function efficiently in an ever-changing work environment. In order to be able to do this, graduates must be able to solve problems, communicate effectively with clients and colleagues, work in teams, think critically, be creative and have sound information technology skills.
- These days, knowledge becomes very quickly dated. Graduates, in order to maintain their place in the employment market, must become flexible and adaptable to the changing conditions. They need to become lifelong learners, open to new ideas and new ways of learning and thinking.
- Graduates need to achieve and demonstrate to employers their acquisition of generic skills that can be applied in a number of contexts.

(The University of Tasmania, 2003, p. 2)

These graduate skills are embedded in university curricula and courses and some graduate outcomes lend themselves to student-centred learning approaches such as effective communication, ability to work in teams and critical thinking. Therefore teachers are being required to use appropriate interactive student-centred teaching and
learning approaches that focus on developing not only disciplinary knowledge but also on facilitating these skills in students.

In Vietnam, there are differences in purposes of physics education and of university education generally compared to the Australian universities. In particular, the Vietnamese tertiary education, being stressed in higher education law, aims not only to train students to have knowledge of their fields of studies but also to have “political and moral qualities”, “good attitudes of serving the people”, and “good health to meet the requirements of building and protecting the homeland” (MOET, 2001, p. 1). Therefore, a range of political, moral and physical education subjects such as Marxist-Leninist philosophy, history of communist party, political economy, country defence education, physical education and foreign languages are embedded in physics curricula of undergraduate courses. The commitment on social science and political subjects in the Vietnamese universities creates an extra workload for students and arguably contributes to an environment that favours teacher-centred teaching methods and also rote learning strategies among the students, compared to the focus on independent learning and action implied by the Australian graduate skills emphasis.

The need to increase the autonomy in Vietnamese higher education institutions in order to have curricula and courses focusing on graduate skills is arguably a critically important part of the process of improving its quality of education and to train graduates who possess knowledge and skills required by workplaces. However, the centralised policy in Vietnamese education system is a constraint that prevents higher education institutions in Vietnam having the autonomy to create their own curricula and courses based on their strengths of research, academics and facilities and resources. Commitment to change or reform on curricula and courses in Vietnamese higher education institutions needs to take in that context.

8.3.2. The ICT infrastructure that makes information available beyond the lecturer

ICTs have changed the way knowledge is delivered to students and the way students receive the knowledge and interact with their lecturers and peers. For example, according to Oliver (2002), ICTs have had an impact on what students learn, how students learn and when and where students learn. In particular, ICTs have shifted the
approach of teaching and learning in higher education from traditional teacher-centred transmissive modes of delivering knowledge to students towards interactive student-centred learning (Hong and Songan, 2011). Jonassen (1995) also states that computer technology can be considered as cognitive tools that support and enable students to learn on their own initiative.

In the Australian universities, the availability of ICTs and the variety of teaching and learning resources enabling by ICTs create a different way of teaching and learning compared to the Vietnamese universities. The Australian students’ learning extended beyond the boundary of the classroom. With the Internet, webpages and educational software, they were able to access their learning materials and communicate, discuss and interact with other peers and with their instructors across a range of times and places. Therefore, ICTs open up a whole lot of possibilities for student autonomy in working and in discussing the applications of physics.

With digital facilities as in the Australian universities, lecturers have powerful tools to supplement their physics instruction in the classroom and reduce the need to present theoretical knowledge, free them from writing constantly, and integrate graphics, animations and illustrations, and examples of real life applications into their lectures. Therefore, ICTs aid students in visualising physics concepts via modelling, simulations and animations. Moreover, the availability of ICTs in undergraduate physics laboratories in the Australian universities make teaching and learning activities in the laboratory more authentic with greater power over report production, collaboration and analysis. They are also able to give feedback to students in a timely way to provide students opportunities to reflect on their work.

Whereas, the lack of that kind of communication infrastructure in the Vietnamese universities is a part of what maintains teacher-centred teaching approaches. Particularly, without the proper integration of ICTs and ICT services into the classroom, laboratory and library, the teaching and learning practice is centred around lecturers because they are the main source of knowledge. This kind of practice, arguably, maintains the authority of instructors within traditional teacher-centred teaching and learning approaches.
The difference in teaching and learning practices of undergraduate physics between the Australian universities and the Vietnamese universities reflects the fact that the Australian universities utilise effectively their existing ICT facilities and digital resources to enhance student learning performance by engaging them in an active student-centred learning environment. In contrast, the perspectives of the Vietnamese lecturers about the move towards interactive student-centred teaching and learning approaches are constrained by the inadequacies of ICT facilities and ICT services.

8.3.3. Resources that make laboratories and tutorial work more group-centred

As described in chapter five, there were significant differences in the teaching and learning practices in tutorials and laboratories between the Australian universities and Vietnamese universities. In the Australian universities, the students have opportunities to experience student-centred learning approaches by participating actively in small group discussions. In contrast, the Vietnamese students attended tutorials involving a large number of students who thus did not have many opportunities to discuss their understanding with lecturers and peers.

The student-centred teaching and learning approaches in the Australian universities’ tutorial sessions and laboratories are supported by a number of factors, in which the availability of infrastructure, facilities, resources and the teaching staff is important. All of the physics departments in the Australian universities had a range of tutorial rooms that were different with lecture theatres and were designed for small group tutorials with several multiple layer boards and moveable tables and benches. The undergraduate physics laboratories in these Australian universities were also equipped with modern facilities and had spaces for students to move comfortably around to discuss with other students and demonstrators. Most importantly, all Australian universities employed sessional staff who were third year students, honours students and graduate students to be tutors and lab demonstrators.

In contrast, the inadequacy of infrastructure such as having not enough classrooms and the lack of teaching and learning equipment and facilities contributed to the problems of large class size in the Vietnamese tutorials and overcrowded laboratories in these Vietnamese universities. Another feature that made tutorial and
laboratory teaching and learning different between Vietnam and Australia was the hiring of sessional staff. In the Vietnamese universities, all teaching staff were academics hence these universities did not have enough staff to cover for many small group tutorials in place of a large class size tutorial. As a result, the possibilities that could open up the opportunities for Vietnamese students to experience small group discussions in tutorials and less overcrowded laboratories include the provision of adequate infrastructures, facilities and enough funding for Vietnamese universities to hire sessional staff.

8.3.4. Different cultural histories

As discussed in the literature chapter, Vietnamese education has been influenced by the country’s tragic history, in which Vietnam was under the rule of many countries. The strong influence of Confucianism characterises the unchallenging attitude of Vietnamese students, especially students in lower levels of education in the classroom. The heavy influence of the Soviet education creates a style of teaching which focuses on theoretical and mathematical knowledge in all levels of education in Vietnam. In addition, higher education institutions in Vietnam are under a highly centralized system of control from the Vietnamese government in general and the MOET in particular. The highly centralised system of control “denies universities and institutes the incentive to compete or innovate” (Vallely and Wilkinson, 2008, p. 3).

In contrast, Australia is a democratic society which encourages the active participation of its citizens in all aspects of its society (DFAT, 2008). This society emphasises the independence and autonomy for its citizens and organisations. In Australia, universities inherit a long tradition of autonomy, which “enabled universities to fulfil their individual missions, diversify and meet the changing needs of the Australian community in teaching excellence, research and research training, and to keep pace with the increasingly competitive international university sector” (Mullarvey, 2005, p. 1). Australian universities have their autonomy on designing and providing courses and curricula that reflect their strengths of research and teaching and learning conditions and focus on students’ needs and generic skills. Also the notion of authority has been eroded and students are seen, and see themselves as much more free agents, with choices.
These differences in cultures affect the way of teaching and learning practices in the classroom. In Australia, the move towards more student-centred in teaching is supported by the democratic features of the Australian society and the autonomy of higher education institutes. In particular, this study has found that the Australian students were encouraged to actively participate in their learning process, especially in the tutorials and laboratories. They also had freedom in asking and challenging lecturers and other students. The Australian lecturers also had more freedom than their Vietnamese counterparts in choosing or modifying subject content and in choosing methods of assessment. Some of the Australian lecturers responded that they were able to choose what they taught as long as it yielded student learning outcomes set out in subject handbooks.

On the other hand, the teaching and learning in the Vietnamese classroom is constrained in the cultural contexts of education. The unchallenging characteristics of the students, the conception of the teacher as expert and sage and the authority of the teacher all create the dominance of teacher-centred teaching approaches in the classroom. Moreover, the influence of the Soviet education, the content of individual physics subjects in Vietnamese universities embraced more theoretical and mathematical knowledge compared to the Australian curriculum. These are some problems that challenge the Vietnamese lecturers in realising their perspectives on moving towards student-centred teaching and learning approaches and hence the process of improving the quality of undergraduate physics practices.

8.3.5. The research focus in Australia and university autonomy in setting curriculum

As described in chapter 4 and 5, all the three departments of physics in the Australian universities had their physics research centres and the main responsibility of the Australian lecturers was doing research. Therefore, most Australian lecturers brought their research skills, cutting-edge knowledge, and applications into their classrooms to show students the meaning of physics theories that they are learning. They also engaged students’ interest in doing research and showed them the importance of research to the development of society. In this way, the research interests of staff open up the view of knowledge as constructed and changing. The strengths of research and research
knowledge and applications in the Australian departments of physics were also embedded in undergraduate physics curricula and courses in these universities.

The close connection between research and teaching in the Australian universities give students opportunities to develop the skills of critical thinking, research methods and independent learning. According to the University of Melbourne (2007, p. 6), “disciplinary research can inform and enhance the teaching and learning environment, benefiting students during their degree studies and afterwards, when they move into the world of employment and lifelong learning”. The benefits that research brings to students include:

- Deepen students' understanding of the knowledge bases of disciplines and professions, including their research methods and contemporary research challenges and issues
- Build students' higher-order intellectual capabilities and enhance their skills for employment and lifelong learning
- Develop students' capacity to conduct research and enquiry
- Enhance students' engagement and develop their capacity for independent learning

The Teaching-Research Nexus (2008, para. 2)

In contrast, as stated by Vallely and Wilkinson (2008, p. 2), “the Vietnamese university system is heavily influenced by the Soviet academic system, in which universities are primarily teaching institutions, while research is carried out by research institutes”. This study also revealed that most of research that the Vietnamese lecturers undertook was in the field of physics education and their research topics arose from their teaching experiences in the classroom and the findings were applied back to the classroom. As a result, students seem to be isolated from disciplinary physics research communities and the knowledge related to research thus comes from second-hand sources rather than from staff directly undertaking disciplinary research.

In the Vietnamese context, the possibilities opened up through the link between research and teaching could be realised by establishing a close connection between researchers from research institutes in Vietnam and university teachers. This connection might be achieved by setting up a dialogue and collaboration between physics departments and physics research centres, which would allow students to access current
knowledge of physics research. In this way, students have opportunities to learn of the
transfer of knowledge from research to recent development in technologies, enabling
them to learn more meaningfully.
REFERENCES


Huong, L. (2008, January 06). Hơn 50% sinh viên tốt nghiệp phải đào tạo lại (More than 50% graduate students have to be re-trained). VnExpress. Retrieved from http://vnexpress.net/gl/xa-hoi/2008/01/3b9fe142/


Mason, M. (2007). Comparing cultures. In M. Bray, B. Adamson, & M. Mason (Eds.), Comparative education research: Approaches and methods (pp. 165-196). Hong Kong: Springer.


Education: Standards, Mechanisms, and Mutual Recognition (pp. 98-101).
Bangkok: Thailand.
APPENDICES

APPENDIX A

Invitation to participate in a research named “Teaching Undergraduate Physics: Prospects for Vietnam from Developed Countries’ Experience”

Dear physics staff

I am Thanh Van Nguyen, currently PhD candidate at Faculty of Arts and Education, Deakin University. My study is under the supervision of Prof Dr Russell Tytler – Science, Dr Peter James Hubble – Science, Dr Christina Hart – science. My study is designed to investigate and compare the undergraduate physics teaching and learning practices between the Australian universities and Vietnamese universities. This letter is an invitation to you to help me with the filling a questionnaire which is the instrument of my research.

The questionnaire aims to find out the current status of undergraduate teaching and learning practices, challenges and changes have been faced and the future directions in teaching and learning of physics.

Your contribution to this research would be invaluable because it helps to improve the quality of undergraduate physics teaching and learning in Vietnam.

Thank you

Thanh Van Nguyen
PART 1. RESPONDENT INFORMATION

1. University: .................................................................

2. Name of department: ............................................

3. Job title: □ Professor □ Assoc Professor □ Senior Lecturer □ Lecturer
   Other: ........................................................................

4. Years of experience in teaching:
   □ Less than 5 years □ Between 5 to 10 years □ Between 10 to 20 years □ More than 20 years

5. Your involvement in teaching:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Level</th>
<th>Responsibility</th>
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<tbody>
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<td>1</td>
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<td>2</td>
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<td>5</td>
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PART 2. CHALLENGES, CHANGES AND FUTURE DIRECTIONS

6. Which of the following issues are the challenges with teaching physics? What is the degree of seriousness? And what approaches do you take to address these?

<table>
<thead>
<tr>
<th>Issues</th>
<th>Very serious</th>
<th>Serious</th>
<th>Little serious</th>
<th>Not at all</th>
<th>Approaches to tackle the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>The poor mathematical background of students</td>
<td></td>
<td>□</td>
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<tr>
<td>The poor physics background of students</td>
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<td>□</td>
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<tr>
<td>Diversity in student population and background</td>
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<td>□</td>
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<tr>
<td>Lack of engagement and motivation in students</td>
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<td>Perceptions of the difficulty of the subject</td>
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<td>□</td>
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<tr>
<td>The increased teaching loads on staff</td>
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<td>□</td>
<td>□</td>
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<tr>
<td>The lack of teaching resources and facilities</td>
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<td>□</td>
<td>□</td>
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<tr>
<td>Other (please specify):</td>
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</table>
7. In these following aspects of physics teaching, to what extent have changes to these been made over the past 5 years? Could you identify the reasons of the changes? What are the main characteristics of the change? How successful have these been in supporting student learning and engagement?

<table>
<thead>
<tr>
<th>Categories</th>
<th>a lot</th>
<th>some</th>
<th>very little</th>
<th>not at all</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Curriculum</td>
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<td>Lecture methods</td>
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<td>Tutorial classes</td>
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<td>Lab work</td>
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Main characteristics of the changes and how successful these are in supporting student learning and engagement

Other comments: ........................................................................................................................................................................

8. Some of the following approaches that have been recommended for teaching physics are: more active learning approaches, use of technology to vary the learning approach, attention to contexts in which the knowledge is used. Which of these approaches do you use and how effective do you find them?

<table>
<thead>
<tr>
<th>Approach</th>
<th>have used</th>
<th>very effective</th>
<th>effective</th>
<th>fairly effective</th>
<th>no effective</th>
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<tbody>
<tr>
<td>Inquiry-based learning</td>
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<td>Context-based learning</td>
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<td>Problem-based learning</td>
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<td>Microcomputer-based Labs</td>
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<tr>
<td>Concept Tests</td>
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<tr>
<td>Modelling</td>
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<tr>
<td>The Force Concept Inventory</td>
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<tr>
<td>Peer Instruction</td>
<td></td>
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<tr>
<td>Projects</td>
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<tr>
<td>Student group presentations</td>
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</table>
9. There has been a move to multidisciplinary and contemporary courses in physics such as nanotechnology, photonics, double degrees. Could you please specify what are the benefits and problems affecting the teaching and learning of physics created by these courses?

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Problems</th>
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</table>

10. Are you involved in the teaching of physics for non-physics majors (e.g. engineering, life science, and medical sciences). Are there particular issues involved in teaching service courses? What strategies do you use to respond to these?

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11. What percentage of importance do you place on teaching compared to research? What percentage of your time is spent teaching related activity? And what are the benefits to teaching from research and vice versa?

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12. What directions will the teaching and learning in your department take in the near future? How do you see your own practice changing to respond to these?

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13. Please write any further comments you may have on future direction in your physics teaching?

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APPENDIX B

Invitation to participate in a research named “Teaching Undergraduate Physics: Prospects for Vietnam from Developed Countries’ Experiences”

Dear students

I am Thanh Van Nguyen, currently PhD candidate at Faculty of Arts and Education, Deakin University. My study is under the supervision of Prof Dr Russell Tytler – Science, Dr Peter James Hubble – Science, Dr Christina Hart – science. My study is designed to investigate and compare the undergraduate physics teaching and learning practices between the Australian universities and Vietnamese universities. This letter is an invitation to you to help me with the filling a questionnaire which is the instrument of my research.

The questionnaire aims to find out the current status of undergraduate teaching and learning practices, challenges and changes have been faced and the future directions in teaching and learning of physics.

Your contribution to this research would be invaluable because it helps to improve the quality of undergraduate physics teaching and learning in Vietnam.

Thank you

Thanh Van Nguyen
### Questionnaire for Students

#### PART 1. RESPONDENT INFORMATION

1. University: .................................................................
2. Department: ..............................................................
3. Gender □ Male □ Female
4. Name of Degree Scheme (e.g. Physics, Physics with Astronomy, Physics with Business Studies) .................................................................
5. Are you studying for: □ BSc □ MPhys/MSci □ Other .................
6. Year: □ 1st □ 2nd □ 3rd □ 4th
7. Are you □ Full-time student □ Part-time student □ Exchange student

#### PART 2. LEARNING EXPERIENCE

8. Could you please specify why did you choose to study physics? And what are the most interesting feature(s) of studying physics?

________________________________________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________________________________________
________________________________________________________________________________________________________________________________________________________________________

9. Which of the following issues are the challenges with your study? What is the degree of seriousness? How do you deal with these challenges?

<table>
<thead>
<tr>
<th>Issues</th>
<th>Very serious</th>
<th>Serious</th>
<th>Little serious</th>
<th>Not at all</th>
<th>Your approaches to tackle the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of mathematic skills</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
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<tr>
<td>Lack of physics background</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Lack of practical skills</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Lack of engagement and motivation in studying</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>The difficulty of the subject</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Lack of problem solving skills</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Lack of learning resources and facilities</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
</tr>
</tbody>
</table>
10. Please describe how these following factors help your physics learning in the following aspects of teaching.

<table>
<thead>
<tr>
<th>Teaching methods (e.g. discussion, demonstration, group work, e-learning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>------------------------------------------------------------------------</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Resources (e.g. notes, learning materials, online activities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>----------------------------------------------------------</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment (e.g. assignments, feedback, problems, revision materials, exams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

11. How would you suggest changes could be made in physics course to better help your learning?

<table>
<thead>
<tr>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
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</table>

12. Could you please describe the learning strategies that you use in these following:

<table>
<thead>
<tr>
<th>In lectures</th>
</tr>
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<td>-------------</td>
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<table>
<thead>
<tr>
<th>In tutorials</th>
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</table>

<table>
<thead>
<tr>
<th>In laboratory</th>
</tr>
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<tbody>
<tr>
<td>----------------</td>
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</table>

<table>
<thead>
<tr>
<th>In doing homework, projects</th>
</tr>
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<table>
<thead>
<tr>
<th>In independent study (e.g. in library, at home, cafeteria)</th>
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<tbody>
<tr>
<td>---------------------------------------------------------</td>
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<table>
<thead>
<tr>
<th>In group work</th>
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<th>When the end-semester exam is coming</th>
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13. Are you studying subject modules outside physics and mathematics in your degree? (e.g. a language, humanities, business, biology)

☐ Yes  ☐ No

a. If you do study non-physics modules, when you began the year did you have:

☐ a free choice  ☐ free choice but recommendations

☐ some choice, some compulsory  ☐ no choice

b. Do you think studying these modules has been:

☐ very valuable  ☐ useful  ☐ a waste of time  ☐ not what I wanted to do

14. How much formal teaching (including lab work) do you have timetabled each week in this semester? 

hours

15. Do you find the overall work load (teaching and independent study)

☐ too light  ☐ too heavy  ☐ about right

16. Do you think you have

☐ too much teaching and not enough independent study?

☐ too much independent study and not enough teaching?

☐ about the correct balance between teaching and independent study?

17. On average, how many hours do you spend weekly at libraries?

hours

18. What activities do you usually do at libraries?

☐ reading  ☐ discussions  ☐ log in Internet  ☐ borrowing books/journals

other (please specify)

19. How often do you use the Internet for retrieving information related to your study?

☐ often  ☐ sometimes  ☐ not often  ☐ never

20. How often do you usually revise new physics knowledge learnt?

☐ after every lecture  ☐ after each chapter  ☐ after each part  ☐ one week before exam

other (please specify)

21. In your physics learning, which of the following methods do you value the most? (Please explain why on the space provided)

☐ concentrate on memorizing physics concept and formulae.

☐ ignore particular subjects that are covered in lectures but are not likely to come up in examinations.

☐ try to understand the meaning of physics concepts underlying behind numerical data and formulae.

☐ find ways to apply formulae to successfully solve homework and exercises.

☐ try to remember the examples and solved problems on text books and on lecture notes.

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22. Please describe how confident you are of developing good physics knowledge and skills during your degree?

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23. Please write any further comments you may have on how to improve your physics learning?

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APPENDIX C

Interview In-depth Questions for Staff

Anticipated Length: 60 minutes

A copy of this interview will be provided in advance of the interview.

Permission to record this interview is requested, to ensure accuracy of the data collected for my study.

Overview:

In my research study, I will explore the current practices, challenges and changes in recent years, and the future directions in teaching and learning undergraduate physics in Vietnamese universities and Australian universities. This interview will explore some issues in more depth than was possible in the written questionnaire.

Current practices:

How much formal teaching do you participate in each week in this semester?
(a) lectures....................hours
(b) labs.........................hours
(c) tutorials.....................hours
(d) workshops/seminars..............hours

What other duties do you have in this department?
(a) research
(b) student advisor
(c) teaching assistant
(d) research assistant

Do you have additional teaching job at other institutions?
(a) Yes. .......................hours/week
(b) No

Do you have enough time to thoroughly prepare for teaching? (Yes/No)

How free are you in terms of choosing teaching content and physics text books, and setting teaching timeline? Do you have to follow your department’s rules other than your adjustment?

Is your teaching (e.g. teaching load, topic taught, methods used) monitored by your department? (Please specify how does the department monitor your teaching and what are the benefit of it?)


In your opinion, what teaching practices help student learn physics best?

How are these represented in your practice? Please describe.

Do you think your assessment regime reveal student understand of physics concept? Please explain.
Some students just concentrate on rote learning 1 week prior to the end-semester exams with the aim of passing the exams rather than understanding physics concepts and acquiring skills. Do you notice that? And how do you deal with this kind of surface learning?

Are there any special features associated with teaching, subject content or assessment of students that are particular effective/successful in your situation? If so, please describe these briefly. How have you measured their effectiveness and what are the outcomes?

Could you please specify advantages and disadvantages that affect your everyday teaching at your department and institution (e.g. resources, facilities, students, leaderships, courses and curricula)?

In what ways is the quality of your teaching judged and supported? (Student feedback, professional observations, interview with coordinators)

How is the quality of teaching and learning in your department assured? Could you please describe the process of quality assurance in your department/institution?

**Challenges and changes:**

Over the years you have been teaching how do you think the curriculum has changed?

- (a) more contemporary topics
- (b) more linked to research
- (c) more relevant to employment
- (d) more exciting topics added

Please describe challenges that you have faced in teaching practices in the last 3 to 5 years and how you have responded to those challenges.

Have there been any significant changes in physics curriculum, program and courses over the last five years? (If so, please specify what have been the changes, what motivated or prompted the changes, and what were the changes intended to accomplish).

Have there been any significant changes in teaching approaches and student assessment process over the last five years? (If so, please specify what have been the changes, what motivated or prompted the changes, and what were the changes intended to accomplish)

**Future directions:**

What directions will the teaching and learning in your department take in the near future? Why? Please note any specific changes that are planned.
APPENDIX D

Interview In-depth Questions for Student

Anticipated length: 45 minutes

A copy of this interview will be provided in advance of the interview.

Permission to record this interview is requested, to ensure accuracy of the data collected for my study.

Overview:

In my research study, I will explore the current practices, challenges and changes in recent years, and the future directions in teaching and learning undergraduate physics in Vietnamese universities and Australian universities. This interview will explore some issues in more depth than was possible in the written questionnaire.

Curriculum, teaching and assessment:

How would you describe differences between secondary school and university in terms of teaching and learning experience?
   (e) Teaching approach
   (f) Independent learning
   (g) Learning environment
   (h) Research

How would you describe the curriculum/syllabus you are offered?
   (e) Proportion of theory and practice
   (f) Mathematics content
   (g) Linked to research
   (h) Relevant to employment

What are your comments on teaching methods and approaches in your department in term of effectively helping you learn physics?
   (a) lectures
   (b) tutorials
   (c) labs
   (d) group work
   (e) other (please describe)

Is the teaching that you have experienced in your department more student-centred or more teacher-centred? Could you please describe?

In your opinion, how should physics curriculum and teaching approach be changed to facilitate your learning?
Do you think that overall, the methods of assessment used are accurately able to reflect your physics knowledge and ability?
Do you have any recommendations on how assessment should be used to reflect students’ level of physics knowledge and ability?

Learning strategies and skills:

What are your reasons for choosing to study physics?
   (c) Physics is interesting
   (d) Physics is linked with technologies
   (e) Career prospects
   (f) Other (please describe)

What are the valuable skills and knowledge you have gained from physics studies?

During your university course, have you been provided with advice or training on how to develop your study skills?

What are most interesting features in your physics studies?

Do you develop any specific learning skills during your physics course?

How do you study in preparation for classes, tests, exams?

Could you please describe a learning strategy that you think the most effective in learning physics?