UNIVERSITY OF SHERBROOKE

La Réussite en Science au Collégial des Étudiants du Secondaire Moins Préparés: Une Étude Longitudinale

The Academic Achievement in College Science of Less Prepared High School Students: *A Longitudinal Study*

par

Elizabeth Barbara Ostrowski Janik

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A été évalué par un jury composé des personnes suivantes :

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SUMMARY

There is a growing concern among educators, researchers, college administrators and the Ministry of Education about declining enrollments and high attrition rates in post-secondary Science education. One reason for the low enrollment is that into the Science Programs in CEGEP is that the admission requirements are based on their Secondary school grades, particularly in their Science and Mathematics courses. This initial screening bars students who may not have attained the necessary background knowledge, cognitive skills and/or emotional maturity required to continue studying in Science. This longitudinal study focuses on the success of CEGEP Science students at one college who were accepted into the Science Program although their Secondary School grades in Chemistry and/or Physics did not meet the admission requirements. These less prepared students were admitted into the Science program because they were placed in remedial classes that offered support through extra class time in their introductory college Science courses. The main research question addressed in this study was to determine whether accepting less prepared students is beneficial to the student in terms of academic success.

This descriptive *ex post facto* research is a longitudinal study that examined the performance of CEGEP Science students spanning over a six year period. Specifically, it compares the performance and retention of regular students with students who were placed in an Extended Lecture Class in their first semester. The independent variable was the extra class time given to the Extended Lecture Classes (ELC). The mean scores, standard deviations, and in some cases, the median grades were used to determine the variability of the performance of remedial and non-remedial students. Performance and retention data was obtained from the college's archives and treated using the SPSS® v.11 statistical software package. The performance of all students was analyzed as a function of which section in multi-section introductory Science courses the students were placed. Also, the performance of remedial students was examined depending on whether they took only Chemistry ELC, or Physics ELC, or both of these remedial courses. The median and average grades in first semester and in subsequent courses were analyzed. The performance of a special group of regular students who were

considered to be academically weak, but who did not benefit from extra class time, was also studied.

The study revealed that the incoming High School grades were significantly higher than grades achieved in first term college courses and the grade distribution was more variable. As expected, students who were academically unprepared had had extra time were more successful than those who were academically unprepared but did not receive remedial support. However, a major finding was that students who displayed a weakness in Chemistry experienced lower grades and pass rates in all their college Science courses. These were found to be the weakest of all remedial students; their performance paralleled weak students who did not have remediation. However, the retention rate for college studies of the Chemistry ELC students was higher than those weak students without remediation, fewer dropped out of the college. Another significant finding was that a majority of less prepared students of the Physics ELC persisted in Science with comparable retention rates when compared to the regular students even though they were experiencing difficulty in their courses. One third of the students in all of the remedial groups' remained on profile in their third semester compared to two thirds of regular students.

Results demonstrate that accepting less prepared students who would not normally be accepted into the Science Program and providing them with support through remediation in Chemistry and Physics is beneficial. The offering of "Extended Lecture Classes" is an effective way to help less prepared students adapt to the rigor of college Science. Although the ELC students did not perform as well as regular students in subsequent courses, their persistence, as demonstrated by the retention rates is a good indicator that these students are on the path to formal operations. These students have been given an opportunity to embrace scientific knowledge that perhaps without the offering of Extended Lecture Class courses could not have been possible.

It appears that the skills required to be successful in Chemistry are necessary for their success in other courses. Therefore, the college might offer a second Chemistry course such as Chemistry NYB with extra time. This recommendation is based on the argument that it has been demonstrated that students who are adequately prepared in Chemistry but are weaker in Physics tend to be more successful in terms of their academic success in Science courses when compared to those who are weak in Chemistry.

This study provides information to the Ministry of Education and college administrators who decide on admission standards and the availability of resources whether providing support for capable but under prepared Science students is one way of addressing the declining enrollments and high attrition rates in Science programs. It also provides educators with an insight into the performance of less prepared students in Science so that they can find ways to increase meaningful learning.

ABSTRAIT

Autant les éducateurs et les chercheurs que les administrateurs et le Ministère de l'éducation du Québec sont concernés par la baisse des inscriptions et par les hauts niveaux d'attrition dans les programmes préuniversitaires de science au Cégep. Une des raisons principales pour laquelle les étudiants postulants ne sont pas admis aux programmes de science est que les conditions d'admission sont basées sur leurs notes, en particulier celles des cours de science et de mathématiques. Ce triage initial exclu les étudiants qui n'ont pas obtenu les habiletés cognitives nécessaires et qui n'ont pas atteint le niveau de maturité requis pour étudier en éducation post secondaire. Cette recherche longitudinale porte sur le succès des étudiants en sciences qui, dans un collège, ont été admis aux programmes de sciences sans toutefois avoir obtenus les notes requises dans les cours de physique, chimie, ou des deux, au secondaire. Ces étudiants moins préparés ont bénéficié d'un enseignement de rattrapage sous la forme de plus de temps de classe pendant leurs cours introductoires de science au collège. Les résultats démontrent que les étudiants qui affichaient une faiblesse en chimie et qui avaient bénéficié d'un enseignement de rattrapage ainsi que les étudiants faibles qui n'avaient pas bénéficié d'un tel apport avaient des notes et des taux de réussite plus bas que ceux qui affichaient une faiblesse seulement dans leur cours de physique préparatoire. Malgré cela, une grande majorité de ces étudiants ont persisté dans le programme. Les habiletés requises pour réussir en chimie sont nécessaires pour réussir dans les autres cours de sciences. La recherche démontre que l'admission d'étudiants moins préparés qui n'auraient normalement pas été admis au programme de science, jumelée à l'offre d'un enseignement de rattrapage en chimie et en physique est avantageux. L'offre de plus de temps de classe est une mesure efficace pour aider les étudiants moins préparés à s'adapter aux rigueurs des sciences du niveau collégial. Cette recherche propose de l'information sur l'efficacité pédagogique de ce type de soutien aux administrateurs du collégial ainsi qu'aux autorités gouvernementales qui décident des standards d'admission et de la disponibilité des ressources. La recherche offre aussi un aperçu sur la performance des étudiants moins préparés, permettant ainsi aux éducateurs de cibler des moyens d'accroître l'apprentissage de leurs étudiants.

ABSTRACT

Educators, researchers, college administrators and the Ministry of Education are all concerned about declining enrollments and high attrition rates in Science Education. One of the major reasons why students are not accepted into the Science Program in CEGEP is that the admission requirements are based on their Secondary School grades, particularly in their Science and Mathematics courses. This initial screening bars those students; who may have not attained the necessary cognitive skills and also may have not reached the maturity required to study in higher post-secondary education. This longitudinal study focused on the success of CEGEP Science students who, at one college, had been accepted in the Science Program although their Secondary School grades in Chemistry or Physics or in both of these courses did not meet the admission requirements. These less prepared students were offered the opportunity to study in Science and were given remedial support through extra class time during their introductory college Science courses. It was found that students who displayed a weakness in Chemistry and had remediation and weak students who did not have the support of remediation experienced lower college Science test scores and pass rates compared to those who had a weakness only in their preparatory Physics course; however, a large majority of these students persisted in the program. The skills required to be successful in Chemistry are necessary for their success in other Science courses. The results of this study demonstrated that accepting less prepared students who would not normally be accepted into the Science Program and providing them with support through remediation in Chemistry and Physics was beneficial. The offering of "Extended Lecture Classes" was an effective way to help less prepared students adapt to the rigor of college Science. This study provides information on the pedagogical effectiveness of this type of remediation to college administrators and government officials who decide on admission standards and the availability of resources. It also provides an insight into the performance of less prepared students so that educators can find ways to increase meaningful learning.

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DEDICATION

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CHAPTER 1

INTRODUCTION

Predicting student performance is an important area in educational research. Over the past decade, there has been a marked decline in enrollments and an increase in the attrition rates in Science programs. There is a general feeling among most experienced teachers that the students of today are not the same as they were twenty years ago. The academic skills in literacy and numeracy have appeared to decline. Nevertheless, despite the Reformed Quebec Educational Program, the admission requirements and delivery of traditional Science courses have remained the same. One of the aims in the Reformed Quebec Education Program (MEQ) is to ensure that everyone in the school system should experience success. This can only be accomplished if the students are given the opportunity to do so. Therefore, it is important to investigate whether there is a benefit to both students and society when the Science admission standards are relaxed and the curriculum is modified to support less prepared students.

The reasons that colleges admit less prepared students range from open door egalitarian policies, declining enrollments and increased funding benefits. Consequently, the colleges are required to intervene and address the needs of these potentially low-performing students by placing them in transition programs that can maximize their chances of collegial success. Educational principles of learning advocate that all individuals have the ability to learn. Furthermore, educational psychologists theorize that not all individuals are at the same stage of cognitive development. Thus, one of the factors that can contribute to performance is that some learners may require varying amounts of time to learn.

This research focused on the study of the academic performance and pass rates of less prepared students who were placed in special extended lecture classes in their introductory Science courses. In addition, it documents the retention of these students in the Science program and in other college programs. These less prepared students had High School Science course grades that did not meet the admission requirements of the Science Program. Nevertheless, the college accepted these students and increased their time on task by providing them with four and a half hours of class time instead of the standard three hours that are given to students who have the prerequisite Secondary School grades in Mathematics, Physics and Chemistry. It is important to note that the content of the ELC (Extended Lecture Class) courses in both Chemistry and Physics was the same as the content studied in regular classes. However, the additional class time allowed teachers to proceed at a slower pace and provide extra in-class examples. It also allowed students to become more engaged in their learning by providing opportunities for in-class discussions and an increased number of practice problems that reinforced theoretical concepts. Moreover, the students had more opportunities to access an expert in the discipline who could clarify misconceptions and erroneous thinking.

To date, there has not been any published longitudinal study of the success and retention rate of students who receive extra class time to learn at the CEGEP level, particularly in Science. A concern is whether accepting under-prepared students into the Science Program gives rise to an "ambition paradox" (Sneider & Stevenson, 1999). Are these students given false hope? Can they succeed? On the other hand, do strict admission requirements unnecessarily bar those students who may not have attained the necessary cognitive skills or affective behavior to study Science in post-secondary education because of developmental issues? Can they overcome these obstacles?

This *ex post facto* descriptive comparative study examined the performance of less prepared Science students compared to regular Science students in introductory college Science courses. Success within a given Science course was credited with a passing grade of 60%. In order to determine whether these remedial courses were beneficial to the students in the long run, a longitudinal study spanning six years examined their performance in subsequent Science courses and retention/attrition rates in the Science Program.

This literature review will attempt to provide a deeper understanding of the complex cognitive structures required for learning Science in an effort to rationalize why certain students experience difficulty in learning Science. It will review the factors that influence learning and the factors that can influence learning rate in an effort to understand why some students take longer to learn than others. It will also provide the philosophical arguments for accepting less prepared students. This study will provide information to college administrators and the Ministry of Education who decide on admission standards and who authorize the availability of resources whether this form of remediation is desirable and beneficial to these less prepared students.

CHAPTER 2
LITERATURE REVIEW

Reasons for admitting students who do not have the necessary academic High School grades for entry into college Science programs can be argued on philosophical grounds as well as supported by the cognitive theories of learning and intellectual development. These different perspective views offer valid arguments why policies of strict admission requirements should be re-examined in order to accommodate motivated less prepared students.

2.1 Philosophical Considerations

There exists a dichotomy in the philosophies regarding the admittance of less prepared students into higher educational institutions. One of the viewpoints is that a relaxation of admission standards through remedial programs diminishes the value and worth of a college degree (Manno, 1995). Would accepting less prepared students lessen the value of the Diplome d'Edutes Collegial (DEC)? Educational research has shown that one of the major predictors of college success is academic preparation. Students who have high-quality coursework (specifically in mathematics) during Secondary school studies are most likely to complete post-secondary education (Adelman, 1999). Although this finding is not surprising, one can use this argument that ill-prepared students will never be successful. Even since the time of Plato, the elitist view of education prevented certain students from entering higher education. Plato (The *Republic)* argued that only those who have a high degree of natural ability should be selected for higher education. This criterion of selection pre-supposes the notion that ability and talent are innate. Only those who show inborn ability should be permitted to continue in higher education for the good of the community (state). He assumed that knowledge acquired through formal education is difficult to attain and not everyone has the capacity. To a large extent this viewpoint still remains pervasive and is a standard held by some educators and administrators in the CEGEP system. These individuals take upon themselves the responsibility to act as "gatekeepers" who guard society from mediocrity. According to this view, when such students are admitted, the standards of the diploma are compromised. Furthermore, a student who does not complete their CEGEP studies in the prescribed period of time (2 years) is deemed unsuccessful or less worthy. To compound the problem, many CEGEP Science courses are slanted toward those who are pursuing a PhD in a specific discipline and not for those who will be pursuing a career in Science (Dickie, 2003). Society and the work force also requires those who can think logically and critically (Woods, Felder, Rugarcia & Stice, 2000). These "gatekeepers" contend that educational institutions should not make any efforts to help these students because it is a waste of resources and encourages a false sense of hope in these struggling students.

Views supporting less prepared students have been advocated by Warnock (1997a). She claims that everyone has an equal right to education; however, education should not be distributed equally because some of the recipients do not need as much while others need more. Her view is a humanistic rather than egalitarian. This view might encourage the special treatment of those less privileged. If being educated is considered a privilege, then less prepared students could be looked upon as less privileged. Hence, a special treatment may be given through additional resources being made available to offer extra class time for those who need it. Moreover, Warnock disagrees with the distribution of education as a commodity. She refers to this distributive justice as politically mediated and that it is at the core of problems in education. Her justification of unequal distribution is based on the argument that it benefits society as a whole. She also agrees with Dewey's view (1989) that education should be tailored to the recipient. In the context of this study, both of these philosophers might have argued that if less prepared students can benefit from more time to learn, then they ought to have the right to this special consideration.

The reasons why many students struggle academically and are less prepared has been the target of many studies. Not only is it necessary to evaluate the philosophical arguments used to set admissions standards and curricular changes, but also, it is equally important to consider educational cognitive research that has identified the factors that influence learning particularly in Science.

2.2 Factors that Influence Learning Ability

Cognitive theories of learning are extensive and well documented in educational research and in many scholarly publications. It is not uncommon to come across educational reviews and research studies that discuss how individuals learn and the factors that influence learning. This literature review will predominantly focus on how students learn Science. Many of the articles sited make reference to constructing knowledge in Chemistry; however, generally other Science disciplines would also require comparable cognitive processes with a similar complexity but would only differ in the process of inquiry (Donald, 2002).

In order to understand how a student learns, it is important to evaluate the cognitive learning theories that influence conceptual change. In an attempt to understand why some students struggle to learn and are sometimes unsuccessful, it is important to understand how the subject matter is learned and also how much time is needed to understand the material. The educator's awareness of the complex cognitive activities that are required to alter and enrich an existing cognitive framework is necessary for effective pedagogical practice. Sometimes there needs to be adjustments to the curriculum to address the diversity of student preparedness, learning styles and the ability to acquire knowledge.

Multiple causal factors influence how learners acquire knowledge and therefore teaching strategies cannot be simply generalized but must be adapted to individual needs. Bloom[1] (1964) in his concept of "*mastery learning*" argues that there are three factors that influence learning that can contribute to achievement. First, by adapting learning-teaching methods in the early stages of learning to those students who have been identified as having differences in their behavior and academic ability may require individualized instruction. At the CEGEP level, addressing behavioral matters is usually the responsibility of the teacher involved and the dean. Giving individualized instruction at this level is impractical. Second, there is a need for an early awareness of affective behavior especially when the student experiences failure. These setbacks in

[1]Bloom was awarded the Phi Delta Kappa award and is quoted from the Monograph 1917 published lecture at the AERA Meeting in New York City February 6, 1971 . The title of the lecture: 'Individual Differences in School: A Vanishing Point?'

learning can impinge on motivational aspects for future learning. Therefore it is necessary to stimulate an optimal initial motivation through encouragement. Students deemed less prepared may have experienced these motivational set-backs during their Primary and/or Secondary schooling. Did these students 'fall through the cracks'? Did their teachers recognize these characteristics and take the necessary action in these earlier years? Third, the instruction should be adapted with a consideration for the time that is required for learning and should use various forms of media. In the context of less prepared CEGEP students, assuming that immature behavior is not an issue, a possible solution could be to adapt instruction that is slowed down.

According to Bloom (1964), a great majority of students are able to learn basic concepts, principles and skills if they are given enough time. John Carroll[2] (1963) claims that 'the most important differentiating factor behind school achievement was time, not differences in some kind of scholastic aptitude' (p 723-733). Carroll argues that test taking is unusually time limited. This measure of academic achievement does not necessarily reflect the learner's intellectual ability. Most CEGEP courses base achievement on test scores. Bloom suggests that the normal distribution of test scores, the famous 'Bell Curve,' is the result of time related factors. Perhaps by extending the time allotted for test-taking, less prepared students could achieve their potential.

Bloom (1976) concluded that differences in students' abilities, rate of learning and motivation for further learning becomes less evident when they are provided with favorable learning conditions. Can these favorable learning conditions be achieved through an extension of lecture time and/or a reduction in course loads?

The goals of instruction in Science, specifically Chemistry, are to acquire domain specific knowledge and problem solving skills within this domain (Heyworth, 1999). Quantitative problem solving that involves formulae and algorithmic applications is difficult for many students. This information processing requires the student to construct representations using a conceptual understanding of the information given in a problem. The scientific community recognizes that knowledge is socially constructed from the perspective of the learner (Driver & Oldham, 1986). This

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[3]Carroll proposed a model to account for school learning. His major premise was that school learning was a function of time. He defined time spent as a function of opportunity and perseverance.

knowledge and understanding can oftentimes be laden with misconceptions. For example, students are required to develop a vernacular vocabulary of words that sometimes may have dual meaning. This can interfere with understanding during instruction if the term implies one meaning and the student interprets it as another. For example, some students have misconceptions about melting and dissolving a substance. Confusion can occur if the teacher is discussing one process such as melting while the student is thinking about dissolving. (Gabel, 1999). This is just one example, there have been many reported in the literature (Mulford, 2002; Peterson (1989); Griffiths, 1989). The learner constructs explanations that make sense to them based on their previous knowledge that has been influenced by the world around them. Sometimes they experience difficulties when they encounter new information that contradicts their alternative view (Mulford, 2002). Secondly, the student must have a strategy to solve the problem. It has been reported that there are two different problem solving strategies are used depending on the experience of the student (Heyworth, 1999; Gabel, 1999). The expert student will begin to solve the problem using supplied information found in the problem since the solver knows the procedure to obtain the answer. The novice solver will attempt the problem using a "mean-ends analysis" which involves a trial and error approach. This novice solver will focus on formulae and equations omitting qualitative thinking and oftentimes will apply rote memory.

Herron (1984) describes learning in terms of stages in the development of knowledge, from surface to deep structures. New knowledge is acquired at the surface level (see **Figure 1.**) through sensory organs and develops in cognitive complexity from "bottom up" processing. "Top-down" processing also occurs when an existing conceptual framework having deep understanding is subjected to an external stimulus that requires understanding a particular meaning of perceptual skill such as deciphering contextual cues. For example, in the Chemistry lab if a student is asked to dilute a solution to a certain concentration, knowledge on the concepts of molarity and common laboratory practice must first be accessed. The incoming CEGEP Science student is more likely to be approaching the stage formal operations schemas whereas the less prepared students would probably be at a stage of concrete operations schemas in terms of their previous Science knowledge.

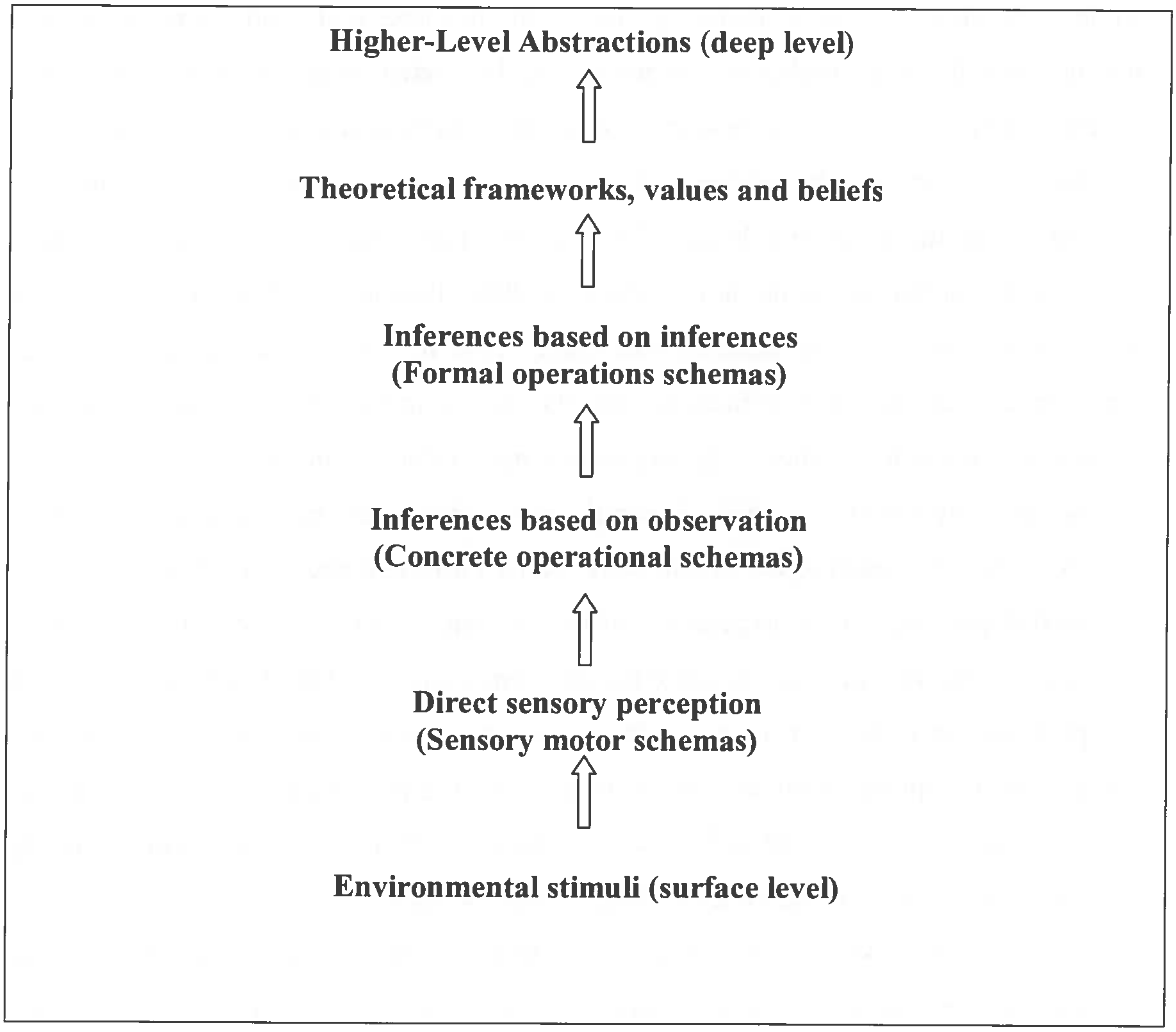

Figure 1. Stages in the development of knowledge, from surface to deep structures.

Johnstone (1993) proposed a mechanism for the learning process similar to that of Herron (1984)[3] in that being presented with an external stimulus (environmental stimuli),

[3] This journal article pertains how information from psychological and educational research might influence decisions on curriculum materials and how to teach a remedial Chemistry course. It focuses on a particular view of the learning process based on research in cognitive Science.

the learner takes action as to whether attention will be focus (See **Figure 2).**

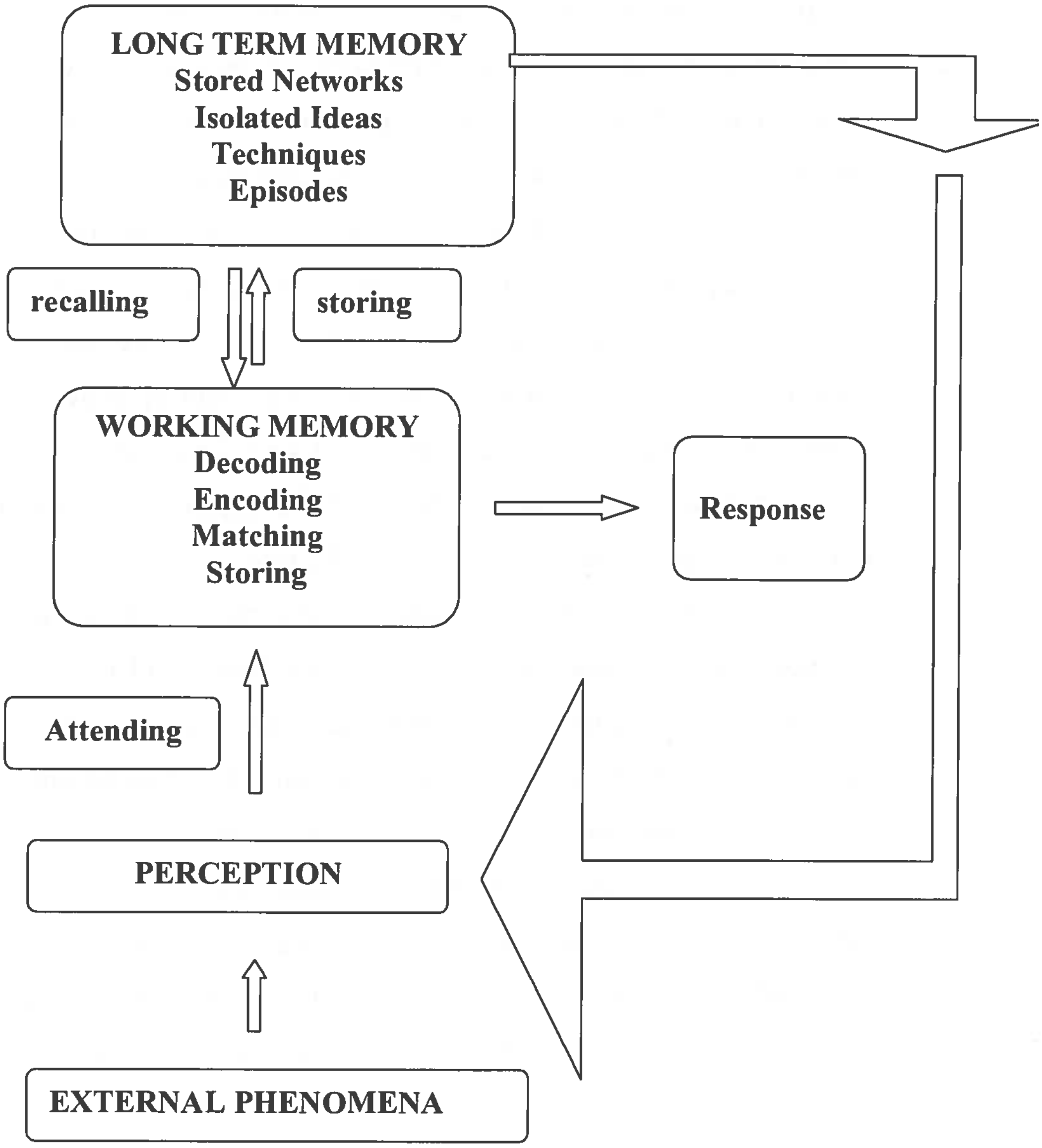

Figure 2. Information processing.

Information that is already stored in long-term memory selects information that is important and disregards that which is perceived as unimportant. Important information is then decoded from previous knowledge and then recoded for storage. Information that is initially encoded and decoded is limited and easily overloaded. Information is stored when links to previous knowledge in the long-term memory exists. In the learning cycle, the learner will attend to information based on prior knowledge in the long-term memory. Once information is encoded, the brain actively interprets the information and draws inferences (Nakhleh, 1992)[4] (Herron 1984), at which time, linkages to existing knowledge are enriched or revised (Vosniadou, 1994). An example is chemical concepts about microscopic views of atoms and molecules that are represented with symbols, formulas and equations. To the novice learner this is very complex since observed events at the macroscopic level are explained at the particulate level (Gabel, 1999). Since these microscopic substances are not available to the senses, the novice learner does not possess long-term memory anchors to link this large network of knowledge and oftentimes, working-memory is overloaded. It is necessary to build on fundamental concepts before advanced concepts could be fully understood. Under prepared students are likely to lack sufficient prior knowledge stored in long-term memory since they probably learned by rote.

The "working memory overload hypothesis" has been of interest to other Science education researchers such as Chandran[5] et al (1987). He concluded that: "Variation in the amount of short-termed memory space is also likely related to variation in Chemistry achievement." Johnstone (1991) points out that 'emphasis should perhaps be placed more often on the "working" and less on the "memory".' Baddeley (1986)[6] and his associates agreed that students who have a large working memory capacity have an advantage in problem solving over those who have a limited capacity. The working memory capacity can account for tasks that involve both processing and storage. Both of these are required for problem solving (Naiz, 1993)[7]. Novice learners

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[4] Presents a cognitive model of learning Chemistry and then discusses students ' chemical misconceptions in terms of a fundamental concept--the particulate, kinetic nature of matter. A cognitive model for learning; Student conceptions of the particulate nature of matter; Students' conceptions of the kinetic aspects of the particulate model of matter; Implications of these misconceptions

[5] Naiz (1993) refers to the work by Chandran et al. on the 'working-memory overload hypothesis' in terms of Science education. Working memory accounts for performance on tasks that involve processing and storage, which are required for problem solving.

[6] Baddeley's working memory model is cited in Naiz (1993) article as an application to Science education.

[7] Naiz outlines two possible models, which have proved useful in studies of information processing in other domains. Information processing capacity as a constraint on the abilities and achievements of Science students; `Mental capacity' and `Working memory capacity' as constraints; Researchers' problems; Suggestions for Science education.

approach problems literally and progress to becoming experts by going through an analytical stage where the time required solving problems increase until well-developed representations of knowledge and strategies are achieved (Donald, 2002). Stahl (1994) found that when students were given time to think in a classroom setting the achievement test scores increased. However, although there is a weak relationship between total study time and test scores, there is a strong effect with time spent on organizing course content through note taking and reviewing, (Dickinson, 1990).

The cognitive operations that are essential to new learning require speed and efficiency. A slowed information processing speed would impede new learning abilities and more trials are required to learn smaller bits of information (Chiaravalloti, 2003). Perhaps less prepared students are those who experience slowed information processing and therefore would require more time to understand. The question that remains is what are the definitive factors that impede this processing speed? Is this indicative that the stage of cognitive development is not what is expected of a college student? Less prepared or novice students may not have the speed to process information relative to higher achieving students. The novice will spend most of the time on developing pattern recognition skills that are subsequently retrieved for future learning outcomes (NRC, 2000). In a study by Demaree et al (1999) on patients suffering from MS demonstrated that the participants were able to successfully complete a working memory task just as well as healthy controls when given more time.

Some less prepared Secondary school students still may not have the cognitive development necessary for higher order thinking skills according to some developmental psychologists. Piaget (1972) describes the maturation process occurring in several stages. He called the later adolescent stage in life as concrete operations. Herron (1984) made use of this maturation scheme to describe his views on the stages of development of knowledge. Critical thinking develops from knowledge stored in long-term memory and the conceptual framework or schema. Long-term memory and the existing schema are accessed in order to analyze and evaluate information. In the Sciences, it is necessary to have an understanding of the knowledge and concepts to be able to retrieve it for critical and abstract thinking. The novice Science student, presumably similar to a less prepared student, has limited previous content knowledge. Thus, the design of classroom activities that fosters critical and abstract thinking at the college level presents a challenge. Critical thinking will develop over time if the students are routinely challenged to think critically within their zone of proximal development (Vygotsky, in Driscoll 2000). Exposing students to this higher level of cognitive function will accelerate the transition to formal operations (Piaget, 1972). Given that the rate of the intellectual maturation necessary to reach formal operations may vary in the incoming college students, is it just to restrict their access to college programs such as Science solely based on their High School scores?

Hirst (1974) claims, in his discussion about changes to curriculum, that it is necessary to take into account sociological and psychological principles that govern curricular changes. Some of these sociological and psychological factors that may influence capacity to learn may be attributed to individuals at different stages of social and intellectual development. There is a current viewpoint that past achievement predicts current achievement (Coley, 1973; McFate, 1999). In the context of access to pre-university programs in the CEGEP system, the High School results are used as the deciding factor for placement. Are these students being labeled simply because some of them are still at the earlier stages of intellectual or social development? Should they be given the opportunity to mature through transitional programs that offer extended lecture time? This study will reveal whether changes to the curriculum such as the ponderation[8] of courses for less prepared students are constructive and practical.

Several models of cognitive learning theory and theoretical arguments pertaining to learning rates have been described. In the context of the less prepared CEGEP Science students, there can be several factors or a combination of factors that may influence their learning speed. Some of these factors can be attributed to their learning strategies. It is possible that these students use rote-learning methods. This may

[8] **Ponderation** is a term used by the Ministry Of Education of Quebec (MEQ) that denotes the number of hours per week in a course devoted to class work, laboratory work and homework (in certain programs it denotes time spent for clinical work). For Example, General Chemistry I NYA has a 3-2-3 ponderation that means that there are 3 hours of class work, 2 hours of laboratory work and 3 hours of homework per week that are designated by the MEQ.

result in a working-memory overload that can impede the cognitive operations that are required for new learning and thus, reduce the processing speed (Johnstone, 1993; Chiaravalloti, 2003). These students would require repetitive trials in order to understand the material. Initially, they approach problems literally and require time to solve problems. The Extended Lecture Class can help them have more time to develop the constructs of the required knowledge and the strategies needed. Rote learning strategy leads to surface learning that is not stored in long-term memory and therefore, it is difficult for them to build on prior knowledge. The dilemma in placing these students into regular classes (3 hours of class) is that college Science curriculum assumes that incoming students should have a basic Secondary school understanding with a limited ability to apply basic scientific principles. Therefore, special considerations need to be made in order to accommodate and support these students. There can be several reasons why students are less prepared in the first place. It could be that they lack intellectual, social and/or affective maturation or perhaps, they never learned the material in the first place because of former teaching practices in their primary and secondary schooling. For whatever the reasons, slowing down the delivery of the material can only benefit these students, as long as they are motivated to learn.

Thus far, the literature review on the theories of the cognitive processes required for learning mainly focused on Chemistry however it does not preclude learning in other Science disciplines such as Biology and Physics. In these disciplines as well as in Chemistry, meaningful learning takes place when the learner constructs and understands new knowledge based on prior knowledge and has a readiness to learn (Finkelstein, 2001). However, the fostering of this constructivist approach in the college classroom is not the norm. Most Science teachers themselves were educated through lecture-based courses and are not trained in education. Many are of the belief that it is their role to transfer knowledge and the students will learn. The most effective way to do this is through lectures (Sanger, 2008). This may not always be effective for less prepared students who are probably trying to recall facts to the best of their ability during the assessment and evaluation of their knowledge. Doyle's (1983) research on academic tasks suggested that some ways teachers could implement the curriculum is by breaking down classroom procedures into measurable units. These academic tasks (units) would focus on a) the products the students are to produce, such as solving a problem b) the operations that students are expected to perform, such as applying an algorithm and, c) the resources that are available to students while fulfilling the task, such as course notes or formulas that are provided on a crib sheet. He proposed that focusing more on academic tasks rather than on content would support more effective student learning. He noted, "Tasks influence learners by directing their attention to particular aspects of content and by specifying ways of processing information" (Doyle, 1983, p 161). These tasks cue students about the essentials that they should focus their attention.

There are some differences in the ways of thinking in Science. Physics is characterized as classical, hard, pure, non-life and pragmatic Science. It is logical, highly structured and analytical. In introductory courses student will often display dualistic thinking and use surface approaches without understanding for learning (Baxter Magolda, 1992; Dickie 2003). Learning is intensive and requires concentration to restructure knowledge (Donald, 2002). This may be particularly difficult for under prepared students since they may not have the necessary prior intellectual skills, previously discussed, to tackle the rigors of this discipline within the usual time given in regular classes. In Chemistry, students are required to learn a large body of knowledge and concepts that need to be assimilated into a framework that is organized which is then used to construct understanding. The learning continuum begins with rote learning that is later developed into meaningful learning. Oftentimes, students will lack understanding between key concepts (Novak, 1984). The discipline of Biology is abounding in factual knowledge especially in introductory courses. Oftentimes memorization is used as a learning strategy. Assessments are usually knowledge based with less emphasis on critical thinking and there is a tendency to use multiple choice formats (Bateman, Taylor, Janik & Logan, 2008; Donald, 2002). This differs from Physics in that it requires the knowledge of algorithms and the application of concepts (Dickie, 2002).

This literature review provides a framework for a better understanding of Science students as well as lays the foundation in support for the findings of this current research which will describe the performance and retention of Science students particularly those who are less prepared.

CHAPTER 3

METHODOLOGY

This research is a descriptive *ex post facto* longitudinal study that studies the performance of CEGEP Science students spanning over 6 years. Specifically, it is the comparative study of the performance and retention of students who were placed in an Extended Lecture Class in first semester Chemistry and/or Physics compared to non-remedial students. The independent variable was the extra class time given to the Extended Lecture Classes (ELC).The mean scores, standard deviations and in some cases the median grades were used to determine the variability of the performance relative to students who did not receive this form of remediation. The comparative study was conducted as a function of the section the students were placed in multi-section introductory Science courses and also as a function of whether they took only Chemistry ELC, Physics ELC, both Chemistry ELC and Physics ELC and finally a special group of weak regular students who did not benefit from remediation through extra class time. The subjects selected had similar academic backgrounds in terms of the pre-requisite courses they took in Secondary school and that they were all enrolled in the Science Program. Extraneous variables such as teacher effects, student schedules and class size could be argued as problematic in the causal conclusion. However, the conclusions were based on the observations of trends and patterns of performance spanning several cohorts that had different learning conditions such as teachers, schedules and class sizes. Moreover, the data collected on the performance of all students in subsequent courses were spread out in different classes with different teachers compensating for these extraneous variables.

3.1 Sampling

The subjects chosen in this study were 467 first semester CEGEP Science students who took Introduction to Chemistry Part I (Chemistry NYA) and Mechanics (Physics NYA) in the first semester at the CEGEP level. Historically, total enrollment for the first semester in college Science can vary from 200 to 350 students per year. The students that were targeted were those of the Fall 2001 (259 students) and the 2004 cohort (208 students). These cohorts were selected on the basis of availability of reliable data provided by the college. The 2001 cohort was selected since it was the first cohort that offered the Extended Lecture Class (ELC). The 2004 cohort was selected as a cut off point since this was the most current data available to study the trajectories of these students that included the 2006-2007 academic year, the expected time of graduation. The 2003 cohort and 2005 cohort data was not easily assessable and therefore was not included in the detailed analysis of the performance in subsequent courses. However, a cursory examination of a statistical analysis of these cohorts using box plots generated by SPSS® v.11 statistical software package afforded descriptive statistics of average grades and ranges of all sections of incoming High School grades that were available and Introductory Chemistry Part 1 (Chemistry NYA), which illustrated the grade distribution by section using the mean, upper and lower quartiles, and the extremes (least and greatest values) for these cohorts. In some rare cases, the High School averages for some students were not available due to transfers from other countries. The purpose was to determine whether these cohorts had similar profiles to the 2001 and 2004 cohorts.

The Science students of the 2001 and 2004 cohorts were distributed among 14 sections taught by different instructors. In Fall 2001, there were 259 students and 208 students in Fall 2004 registered in the Science Program. One section in each of the first semester introductory Science courses, Chemistry NYA (52 students) and Physics NYA (47 students), provided an extra one and a half hour of lecture time per week to less prepared students. This form of remediation was offered only in the fall semester. These special sections will be referred to as the "Extended Lecture Class" (ELC Chem) for Chemistry, ELC Physics. The students who were registered in these "Extended Lecture Class" sections were those who passed the pre-requisite High School Science/mathematics courses but did not meet the grade requirement of 70% in either Chemistry or Physics or both. However, these students were required to have an overall High School grade average of 80%. The remaining sections will be referred to as the "regular" students (320 students) and are coded as "none" in the data which indicates that they had no remediation in these Science courses. The regular sections had 3 hours of lecture and 2 hours of laboratory experience. The students who qualified to be admitted in these sections had a minimum of 70% in each of the High School Science/mathematics pre-requisites. The performance of a fourth group was examined. These students (25 students) were in regular sections of the first semester Science courses and achieved less than 65% in their first semester college courses and had less than an 80% overall High School average. These students will be referred to as "Weaker-no remediation".

The special section of Chemistry ELC had 37 students in the Fall 2001 cohort and 40 students in the Fall 2004 cohort. There were 40 students in the Physics ELC in 2001 and 32 students in 2004. Some of these students took both Chemistry ELC and Physics ELC in the same semester; this group will be referred to as "Both" (25 students).

3.2 Data Collection and Instruments

The main focus of this study was to analyze the performance of those students who were enrolled in the "Extended Lecture Class" and compare them to the regular sections. The grades of all first semester Science students were analyzed as a function of the different sections taught by different instructors. Also, for the purposes of establishing the preparedness of Science students, the High School entrance scores of those who were also enrolled in the ELC was be analyzed and compared to the grades of regular students and regular students who had less than 65% in their Chemistry NYA, the first semester Chemistry course.

The Extended Lecture Class clientele profile for both Chemistry NYA and Physics NYA was established on the basis of the High School average of courses that have Ministerial courses required for a DES (Diplome Etudes Secondaire). These Ministerial High School courses have comprehensive final exams set either by the Ministry of Education or by local school boards. The High School grades of Physical Education and those of Religious and Moral Education courses were excluded. A comparison of the spread of average grades of the incoming High School graduates who had the necessary pre-requisite marks in their High School Science and Mathematics courses was compared to the ELC courses. A descriptive statistic of range of the High

School averages as a function of the sections of Introductory Chemistry Part 1 (Chemistry NYA) and Mechanics in Physics NYA was determined using the SPSS® v.11 statistical software package. The box plots demonstrated the grade distribution by section using the mean, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdrawal period are not included. The box plots for the 2001, 2003, 2004 and 2005 cohorts were produced. The 2001 and 2004 cohorts were analyzed according to statistical measures that compared the variance of scores in the different sections using the mean and standard deviation of the grades. The patterns of the box plots for the 2001, 2003 and 2005 cohorts were observed in order to establish whether the ELC students of these cohorts performed similarly in first semester courses to those that were analyzed in detail.

A more detailed analysis of the average High School grades of the 2001 and 2004 cohorts was studied in order to establish whether the performance in subsequent college level courses varied according to different groups of students within the ELC sections. It entailed the analysis of average High School grades dependent on which category the students entered the Science Program at the college level in 2001 and 2004. The students were subdivided into categories according to how many ELC courses they were taking. There were 40 students who were placed only in the Chemistry ELC; 47 students who were placed only in the Physics ELC; 25 students who were placed in both Chemistry and Physics ELC; 343 students who did not take any ELC courses and were enrolled in the regular stream. Additionally, in order to compare the effectiveness of having extra time given for lectures in the ELC, 15 students from the 2001 cohort were grouped whose incoming High School average that less than 80% and had less than 65% in Chemistry NYA but were not enrolled in any ELC and were labeled as "weaker non-remedial". The High School grade averages, standard deviations were analyzed by cohort for these categories of students using SPSS® v.11 statistical software package. The data was collected and tabulated by cohort and a summary spanning over the two cohorts was prepared.

3.3 Performance in College Level Science Courses

To determine the performance in college level studies, the grades of the ELC by sections of Chemistry NYA and Physics NYA were collected and compared to the regular classes. The tool that was used for these data analyses will be the SPSS® v.11 statistical software package. The statistical measures that were used to compare the variance of scores of the different sections in Chemistry and physics were the mean and standard deviation of the grades. The significance of variance between the groups was established by visual characterization of the box plots of the grade distribution by section. These box plots statistical information such as the median, the range of the upper and lower quartiles and the extremes (least and greatest values). The performance outcomes in the subsequent courses in the Science Program such as Introduction to Chemistry Part II (Chemistry NYB), Biology I (Biology NYA) and Physics III (Physics NYB) was also analyzed using the same statistical analysis as described above. The ELC students were targeted using cross tabulation of student identification numbers for those who were enrolled in Chemistry ELC and/or Physics ELC. It should be noted that these subsequent Science courses did not offer additional lecture time. The ELC students are randomly distributed among various sections of these courses in the semesters that followed.

The performance in terms of average grades of the ELC students as a function of which ELC class they were enrolled and the performance of the weak non-remedial regular students was compared to regular students in their first semester courses such as Physics NYA and Chemistry NYA. The performances of these same groups were compared in subsequent courses such as Chemistry NYB, Physics NYB and Biology NYA.

3.4 Pass Rates by Group

A detailed analysis of stem and leaf plots generated by SPSS® v.11 statistical software package of individual grades in courses such as Chemistry NYA, Physics NYA and Biology NYA for the 2001 and 2004 cohorts afforded data relating to the pass rates in these courses as a function of which ELC group the students were enrolled, as described previously. A comparison was made with the regular students and the non-remedial weak students. It entailed the analysis of 467 students in terms of those who failed or dropped the course, those who passed with grades in the sixties and those who were above 70%. The data gathered was reported as a percentage based on the total number of students enrolled as a group. The results were tabulated. There were 52 students who were placed only in the Chemistry ELC; 47 students who were placed only in the Physics ELC; 25 students who were placed in both Chemistry and Physics ELC; 343 students who did not take any ELC courses and were enrolled in the regular stream.

3.5 Retention Rates and Program Profiles

Student retention rates and achievements in the Science Program for the Fall 2001 and Fall 2004 cohorts was studied over five years (2001-2006). Students normally graduate from the program after 4 semesters. Cross-tabulation of students initially registered in Chemistry NYA at the beginning of their college studies was used to determine if the students persisted in the program, transfer to other programs or abandon the college. In order to establish whether there was a difference in whether students took more than one ELC class, students were subdivided into groups as before; those that took only Chemistry ELC, those who took Physics ELC; those who took both Chemistry and Physics ELC; those who were not registered in any ELC and those who were not registered in any ELC but had less than 65% in Chemistry NYA. The data was summarized and tabulated using SPSS® v.11 statistical software package.

3.6 Coherence and Alignment of Introductory Courses

The instructional objectives, learning activities, assessments and the performance criteria of the various sections of introductory Science courses was analyzed in order to establish whether the students of the ELC classes and regular classes were similarly challenged. The course outlines for all sections of Chemistry NYA, Biology NYA and Physics NYA for the Fall 2001, 2002 and 2003 cohorts analyzed according to the marks assigned to different assessment tasks. The source of the data that analyzed the coherence of the different sections of introductory Science courses previously mentioned that were given in Fall 2003 and Fall 2004 academic years was based a previous study that this researcher co-authored (Bateman, Taylor, Janik & Logan, 2008). This study revealed the coherence between multiple sections in terms of the types of knowledge required in the assessments, as well as, the level of cognitive complexity demanded of the student according to Bloom's Taxonomy (Bloom, 1964; Krathwohl, D. R. (1994).

3.7 Ethical Considerations

Application to Champlain Regional College Ethics Committee was made for approval for the use of student grades. The analyses and results of the grades did not have any identifying features such as names or identification numbers that singled out any particular student. The identification number was only used to track the students in subsequent courses using cross tabulation using SPSS® v.11 statistical software package. These grades were analyzed by a section of a course and not specific to any particular student. Therefore, it is deemed that no student consent forms were necessary. The Ethics Committee of Champlain College Saint Lambert approved the informed consent. The application for consent consisted of a statement of the purpose, brief literature review, a description of the procedures and instruments that was going to be used and a bibliography. See **Appendix 19** for the consent form used.

CHAPTER 4

DATA AND RESULTS

4.1 Coherence and Alignment of Multi-Sections Introductory Courses

In order to establish whether the students in both the ELC and regular classes were challenged using the same instructional objectives, learning activities and performance criteria, the course objectives and marking schemes of the various sections were analyzed in the Chemistry NYA course (Introduction to Chemistry Part I) for coherence and alignment. The marking schemes for the multi-sectional courses were analyzed for the 2001, 2002 and 2003 cohorts (**APPENDIX 1**). Generally, final grades for courses consisted of 3 class tests or 2 class tests with quizzes, a laboratory component 15%, Integrative Activity Project 5% and a common final exam. All sections wrote a common final exam covering the entire course material that was given each semester and common course objectives were given to all cohorts. In addition, the final exams were graded by common marking by all the instructors teaching this course in order to ensure equity of assessment. Most sections based their final grade on a flexible grading option for class tests, course work and the final exam weighing 50% or 30%. In one case, the final exam was weighed at 40%. This flexible grading scheme was adopted particular to each student depending on whichever option was more advantageous to the student. In addition, all students used common laboratory manual as well as the textbook.

Another aspect that was examined was whether the ELC students were challenged with the same content and level of difficulty according to Bloom's Taxonomy (Bloom, 1964) within their assessment tasks compared to regular students in Chemistry NYA, Physics NYA and Biology NYA. The data reported was based on a recent study of curriculum coherence in this college. This study examined the coherence in terms of the degree to which the intended learning outcomes (instructional objectives), the instructional processes (learning activities) and the assessments (formative and summative evaluations of student learning) were connected. The alignment within multi-section courses was analyzed in terms of the types of knowledge required by students and the cognitive complexity according to Bloom's Taxonomy for the Fall 2003 and Fall 2005 cohorts (Bateman, Taylor, Janik & Logan, 2008). It was found that the variations between the sections seemed to be fairly coherent. The predominant type of knowledge required for the assessments in Chemistry NYA was conceptual knowledge with variations of 51.4% to 67% (average = 59.9%) of the total grade for the course being attributed to the use of this knowledge. The Extended Lecture Class had 60.6% of the grade attributed to assessments that required conceptual knowledge (**Graph 1, Section C21 in APPENDIX 2**). The requirement of the use of procedural knowledge ranged from 28.3%-37.4 (average = 32.6) for all sections. The ELC group had 35% of the mark value of assessments that required procedural knowledge. In most cases, only a small proportion of the grade required factual knowledge. In fact, the ELC group had less than 5% of the grade requiring factual knowledge compare to some that had 11%. Similar results were found in the 2005 cohort. This indicates that not only was the type of knowledge required by students consistent across sections but also was coherent over several cohorts.

Analysis of the cognitive complexity of all the sections revealed that a majority of the grade was attributed to application type questions 59.4%-71.6% (average = 64.2%) for all sections. The ELC group had 59.4% of the course mark attributed to application questions. The mark value of the items that required analysis, which is more difficult than application according to Bloom (Bloom, 1964), ranged 2%-16.8% of the overall grade. The average for all sections was 10.5% and the ELC group was 13%. It appears that this course was pitched slightly higher than the average; however, the average was lower than expected due to section C31 that had less than 2% analysis type assessments (**Graph 2, APPENDIX 3**). Without this section the average would be 11.6%, thus, it was assumed that the ELC section was also assessed with at the same level of cognitive complexity as other sections discounting C31 especially since there were 8 sections offered that semester and only one of these sections (C31) was significantly different. Similar results were found in the 2005 cohort.

The analysis of the coherence in Biology NYA in the above mentioned study (Bateman, Taylor, Janik & Logan, 2008) showed that there existed a disparity between the sections in terms of the objectives that were being addressed in class. A large majority of the assessments required students to recall factual knowledge and to have a conceptual understanding. The ELC students were spread out among these sections. This differed from Physics NYA where the emphasis in the assessments was placed on the applications of procedural knowledge to solve problems. The study revealed that there was a lack of coherence in terms of the number of assessments and the emphasis on different objectives varied significantly across the sections. The level of difficulty and the objectives addressed in the Physics ELC class appeared to be within the norm in terms of the cognitive complexity and the types of knowledge required in the assessments when compared to other sections of this course. In other words, this course was not easier or harder when compared to other sections.

4.2 Overall High School Performance

The average High School scores of the 2001, 2003, 2004 and the 2005 cohorts for all incoming High School Science oriented students as a function of which the section of Introductory Chemistry Part 1 (Chemistry NYA) they were placed was analyzed according to the grade distribution by section using the mean, median, upper and lower quartiles, and the extremes (least and greatest values) using box plots (**APPENDIX 4**). These box plots illustrate that the spread of the High School grades have similar patterns for all the cohorts studied. The standard deviation for all of the sections was less than seven ($SD < 7$) indicating that there was little variability within the sections. However, the ELC groups were unique with respect to the mean scores because it was lower than all of the other sections with the exception of one of the sections in the Fall 2004 cohort that had approximately 33% of the students had incoming grades less than 80% (**See Figure 3,** Box Plot 1, section 191). The ELC classes in all cohorts had a mean grade less than 80% in High School scores that consisted of the Ministerial courses required for a DES (Diplome d'Études Secondaire) and were less prepared than regular students who average High School grade was greater than 80%. **Figure 3**, Box Plot 1 and **Table 1** below illustrates an example of the spread of the incoming grades for the 2004 cohort as a function of the section the students were placed. The ELC Section (section 173) had a mean score of 78.5% with a small degree of variability within the class (SD = 3.58), however, there was a significant variance between sections.

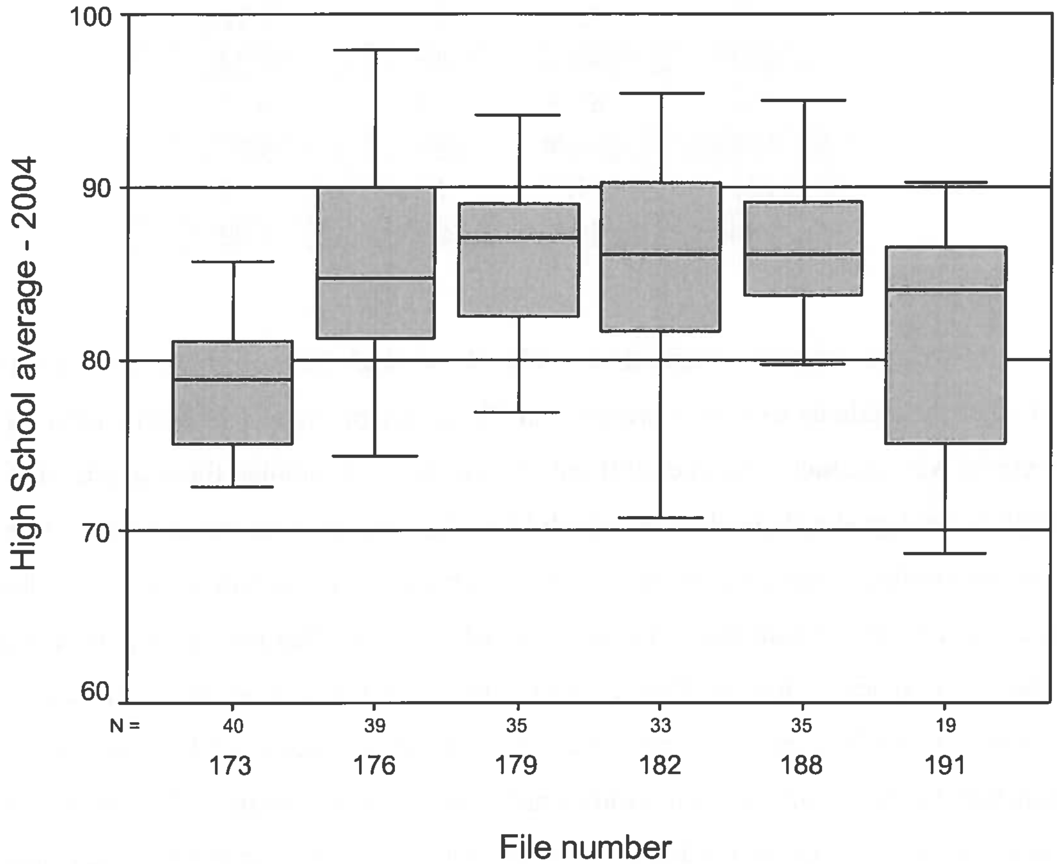

Figure 3. High School averages of the 2004 Cohort as a Function of the Chemistry NYA Section

Box Plot 1 represents the range of the High School grade as a function of the sections of Introductory Chemistry Part 1 for the 2004 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. The ELC group has file number 173. All remaining file numbers are the regular students. Note: Section 191 has approximately 1/3 of the students that are below 80%.

Table 1. Average High School Scores as a Function of Chemistry NYA Section Fall 2004 Cohort

File Number	Mean	N	Std. Deviation
173 ELC	78.5	40	3.58
176	85.5	39	6.10
179	86.1	35	4.38
182	85.4	33	6.07
188	86.4	35	4.07
191	81.2	19	6.59
Total	84.0	201	5.90

A more detailed comparative study of the High School grades as a function of whether the students were less prepared in Chemistry or Physics or both within the ELC sections was conducted for the 2001and 2004 cohorts. It entailed the analysis of average High School grades dependent on which ELC class(es) the students entered in their first semester college level courses in the Science Program. These categories were classified according to those students who were placed only in Chemistry ELC; those students who were placed only in Physics ELC; those students who were placed in both Chemistry and Physics ELC; those students who did not take any ELC courses and were enrolled in the regular stream. Additionally, in order to compare the effectiveness of having extra time given for lectures in the ELC, a group of students whose incoming High School average that less than 80% and had less than 65% in Chemistry NYA but were not enrolled in any ELC in the 2001 cohort was examined (**APPENDIX 5**). The spread of the average High School grades were similar for all categories of students for all of the 2001 and 2004 cohorts when analyzed by section. However, tabulation of the results averaging the outcomes over these two cohorts revealed that students requiring only Physics ELC in both cohorts appeared to be slightly stronger (see **Table 2** below). These mean scores clearly indicated that the students enrolled in the ELC classes were not as well prepared as the regular students. The 50 students who were registered in Chemistry ELC did not meet the grade requirement of 70% in High School Chemistry had a High School average of 77.9% (SD=3.09-3.58); 44 students enrolled in Physics ELC did not meet the grade requirement of 70% in High School Physics had a slightly higher average of 80.1% (SD=3.48-4.90); 24 students who were registered in both Chemistry and Physics ELC and did not meet the grade requirement of 70% in High School Chemistry and Physics had an average of 78.6% (SD=3.12-3.59). The 307 regular students in the Science Program had higher entrance scores having a mean of 86.1% (SD=5.26-52). The 2001 cohort of weak students who did not have the opportunity to be enrolled in any ELC class had the lowest average of 76.9%. These students may have had the prerequisite 80% average in High School Chemistry and Physics but were slightly less prepared based in their overall High School grade.

Table 2. Su… ses for the Five Catego… ort.

Category	Average Mean	N	Std.Dev. Range
Chemistry ELC	77.9	50	3.09-3.58
Physics ELC	80.1	44	3.48-4.90
Both Chem. & Phys. ELC	78.6	24	3.12-3.59
Regular students	86.1	307	5.26-5.52
Less than 80% in HS	76.9	15	1.67
Totals for all Cohorts	84.2	493	5.38-5.90

An in depth analysis of the 2001 cohort box plot and tabulation of results (see **Figure 4**, Box Plot 2 and **Table 3)** illustrates the spread of the grades. It shows a small degree of dispersion within the groups; however, the variance between the regular students and the ELC students is significant. The regular students scored an average of 86.1% whereas the weakest students were those who did not have the opportunity to be in ELC had an average score of 76.9%.

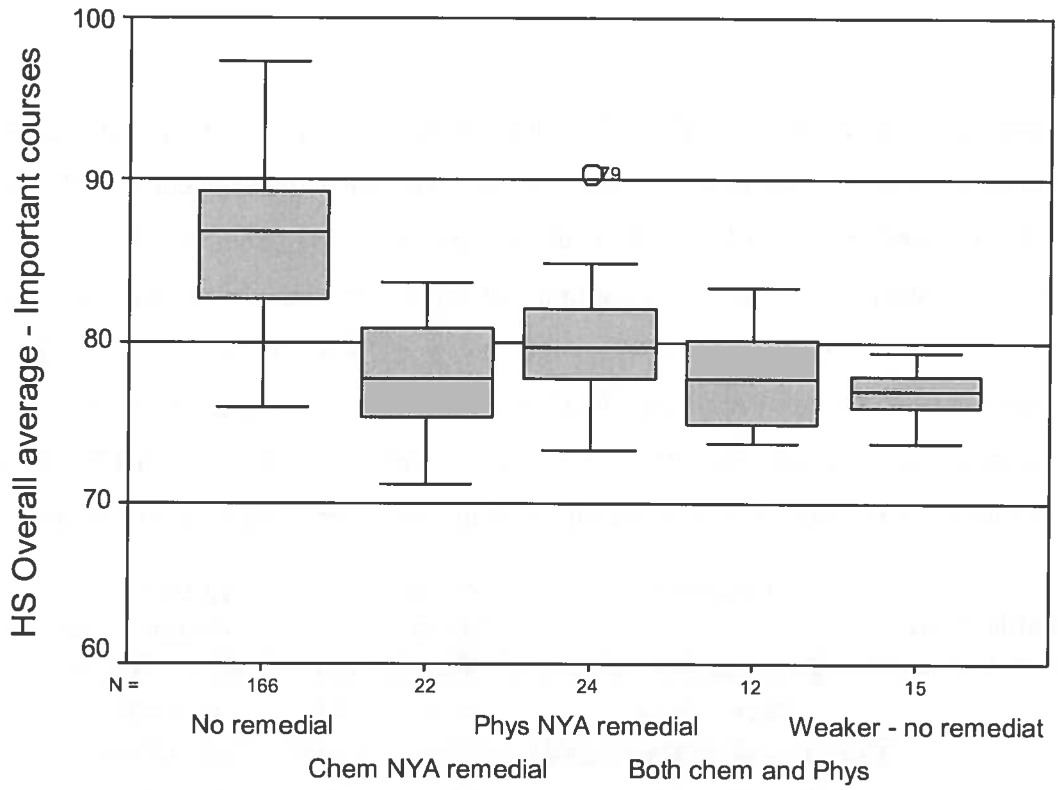

Figure 4. High School averages of the 2001 Cohort as a Function of the groups within Chemistry NYA

Box Plot 2 represents the range of the High School grades for the 2001 cohort as a function of the groups within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physics NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physic); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table 3. Average High School Grades of Benchmark Courses for the Five Categories of Science Students Enrolled in the 2001 Cohort.

Group	Mean	N	Std. Dev.
Chemistry ELC	77.8	22	3.09
Physics ELC	80.2	24	3.48
Both Chem. & Phys. ELC	77.8	12	3.12
Regular students	86.1	166	4.35
Less than 80% in HS and 65% Chem NYA	76.9	15	1.67
Totals for Cohort	83.8	239	5.38

4.3 Performance in Chemistry NYA

Chemistry NYA is normally taken in the first semester along with Physics NYA and Calculus NYA. In order to show that the patterns of the Chemistry NYA grades were consistent with the patterns of the High School grades, an analysis of box plots showing the spread of the average grades in Chemistry NYA by section compared to the High School grades indicated that there was a strong correlation (See **APPENDIX 6**).Those sections that entered with higher High School averages performed better than those sections that had lower incoming grades. It was noted the overall average High School grade of 84.2% was significantly higher than the first term overall college grades that was 69.7% for the 2001 and 2004 cohorts. The spread of the grades was much wider in range for the Chemistry NYA grades (SD ranged from 11.3 to 18.7) when compared to the range of the standard deviation of the High School averages (SD = 2.37-6.01). This is most likely due to the admission requirements for the Science Program being set at a relatively high grade level, 80%. As a result, the variance in the High School grades is relatively small when compared to other programs offered in the college such as Social Science. However, it was noted that there was a variation of Chemistry NYA grades between the various sections.

Figure 5, Box Plot 3 **and Table 4** below illustrate an example of the variance in the Chemistry NYA grades for the 2004 cohort as a function of the section in which the students were placed and is consistent with the findings for the Fall 2001 cohort (see

APPENDIX 4 for the High School Grades by section and **APPENDIX 6** for the Chemistry NYA by section). The ELC section (Section 173) had a mean score of 60.7% (SD = 12.0) compared to 70.4% for the regular students' average score. Interestingly, there was one section (Section 191) that performed similarly to the ELC section with an average score of 60.7%. Further investigation of the High School averages indicated that this section that had approximately 8 students who had below 80% overall incoming average. The overall average grade in Chemistry NYA for regular students' increased to 72.5% if the ELC group and this non-remedial low performing group was not included in the overall average.

Table 4. Average Chemistry NYA Scores by Section for the Fall 2004 Cohort

File Number	Mean	N	Std. Deviation
173 (ELC)	60.73	40	11.964
176	74.08	39	15.918
179	70.66	38	11.840
182	71.91	34	17.705
188	73.38	37	13.508
191	61.85	20	13.758
Total	69.23	208	15.031

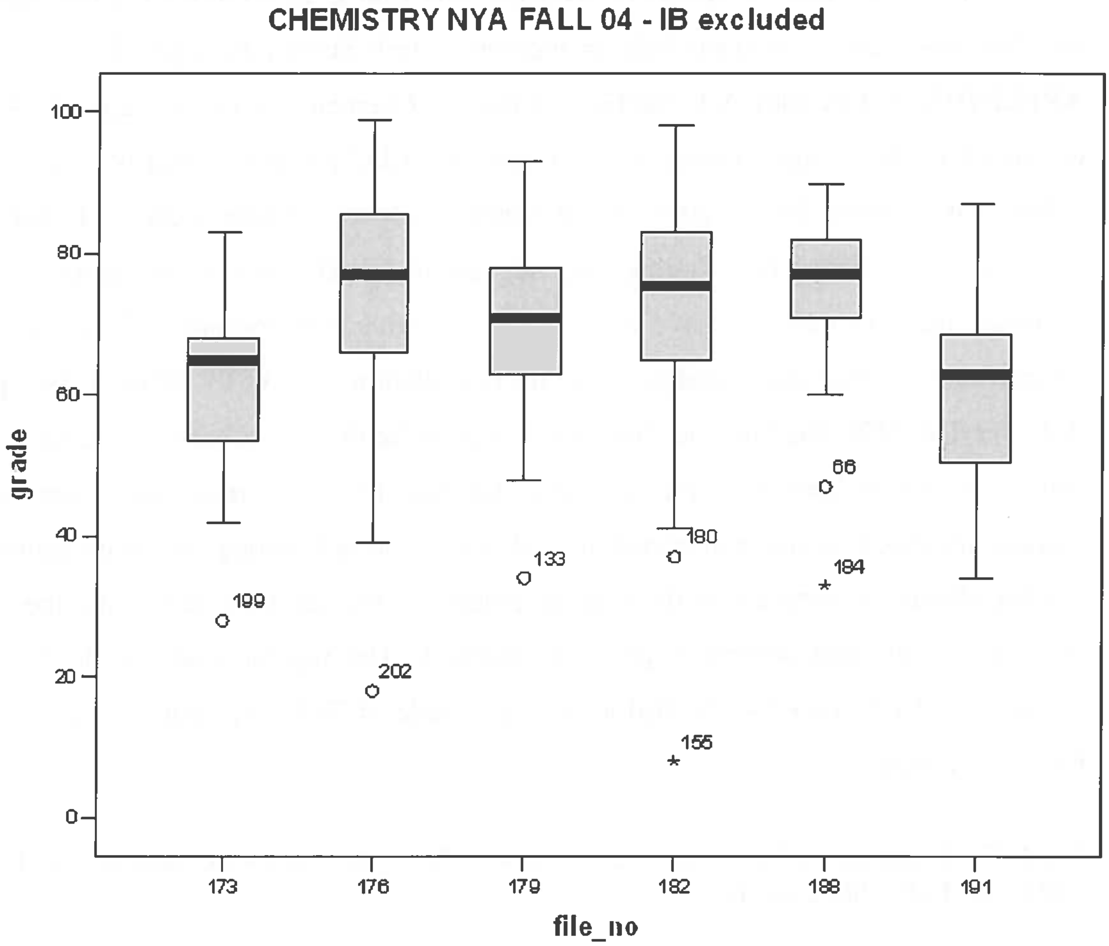

Figure 5. Performance in Chemistry NYA Fall 2004 Cohort by Section.

Box Plot 3 represents the median grade and range of all sections of Introductory Chemistry Part 1 for the 2004 cohort. It shows the grade distribution by section using the mean, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. File number 173 is the ELC section. All remaining file numbers are the regular students. Note: section 191 has some students who do not have an 80% overall High School average.

In the 2001 cohort (see **APPENDIX 6, Box Plot C.1, Section 143**), one section that had less than 13 students had an incoming High School average of 78.6% (see **APPENDIX 4, box plot A.1, Section 143**)and a Chemistry NYA average of 68.9% compared to the overall average of the Chemistry ELC group that had 65.4% in that cohort. The average for the 2001 cohort regular students, without section 143 and the ELC group is 70.8%. This finding may suggest that having extra time given to less prepared students may not have an effect in improving performance. However, the sample size of those weak students with no remediation (see **APPENDIX 4, box plot A.1, Section 143)** was low and therefore it was difficult to conclude that remediation had no effect in benefiting the students. Additionally, there may have been some extraneous effects in this non-remedial weak section as scheduling, group dynamics or teacher effects. A summary of the average grades for the regular students and the ELC students for the two cohorts is given in **Table 5.** The regular students clearly out-perform the ELC students who had an average grade of 70.5% compared to 63.1% for the ELC students.

Table 5. Summary of the Average Chemistry NYA Scores by Section for the Fall 2001 and Fall 2004 Cohorts

Group	Mean	N	Std. Deviation Range
ELC	63.1	75	12.0 -18.7
Regular Students	70.5	396	11.4-17.7
Total	69.7	471	11.4-18.7

The analysis of the Chemistry NYA average grade depending on which group the students were in, as described above, was conducted. **Figure 6**, Box Plot 4, represents the range of the performance of all sections of Introductory Chemistry NYA for the Fall 2001 cohort. This box plot was chosen as a sample to illustrate the visual characteristics of the data that was also observed in the 2004 cohort (See **APPENDIX**

7). The graph below shows how the first semester students performed as a function of the category (group) they were enrolled. This data shows that the ELC groups were within the range of the non-remedial groups that were registered for Chemistry NYA. As expected, the ELC classes that had lower entrance scores than the average Chemistry NYA grades for regular students. However, a surprising finding was that those students who required both remediation in Chemistry and Physics performed better than those who only had ELC Physics or ELC Chemistry. Figure 6 clearly indicates that even though most of the ELC students succeeded (60% passing grade) in Chemistry NYA, a large majority of them were passing in the 60-70% range which is lower when compared to the regular students whose median grade was 75%. The same trend was observed in the 2004 cohort.

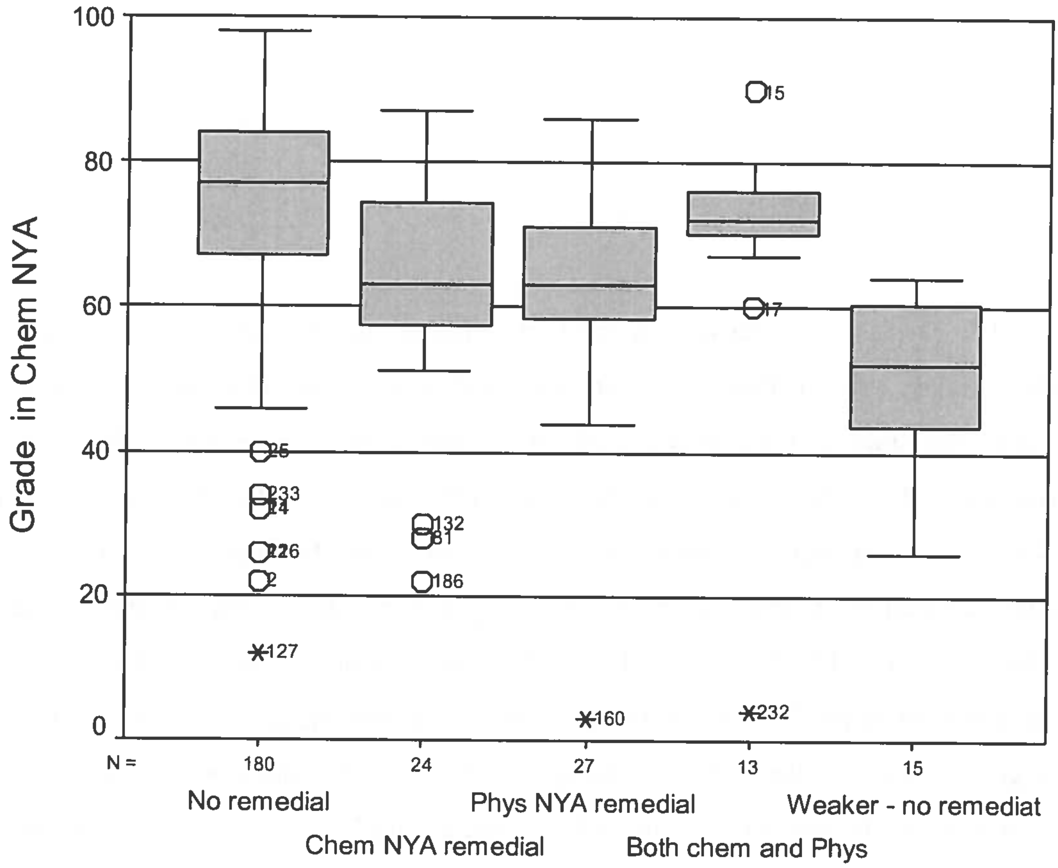

Figure 6. Chemistry NYA grades for the Fall 2001 Cohort as a Function of the groups.

Box Plot 4 represents the range of the Chemistry NYA grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physics NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physics); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

The mean score for all groups was 70.2% (SD ≈ 16) (See **Table 6** for summary). The 52 students in the Chemistry ELC group had a lower average with a mean grade of 61.8% (SD≈ 17) whereas the 328 students in the non-remedial regular group had a mean score of 79.5% (SD ≈ 14.5). For those 47 students enrolled in Physics ELC, the mean score was 60.6% (SD ≈ 16.5);the 25 students who were enrolled in both Chemistry ELC and Physics ELC had a mean score of 64.8% (SD ranging from 11.4 to 20.6). The data indicated that students with only Chemistry ELC performed slightly better than those who were enrolled in Physics ELC and also those who were enrolled in both. However, the 15 weak students with no remediation in Chemistry or Physics had a mean score of 51.3%. These students performed considerably more poorly than those who had remediation or were in the regular stream.

Table 6. Summary of the Average Grades in Chemistry NYA for the Five Categories of Science Students Enrolled in both the 2001 and 2004 Cohorts.

Group	Mean	N	Std. Dev. Range
No Remedial	79.5	328	14.0-14.9
Chem NYA remedial	61.8	52	17.1
Phys NYA remedial	60.6	47	16.0-17.0
Both Chem and Phys	64.8	25	11.4-20.6
Weaker, no Remediation 2001 cohort	51.3	15	11.0
Total	70.2	467	15.0-16.6

The pass rate in Chemistry NYA of the 343 regular students that included the weaker non-remedial students was 87.6% for the two cohorts studied (see **Table 7**). The pass rate for the 52 students enrolled in Chemistry ELC was 67.7% (see **APPENDIX 8** for individual cohorts). These ELC students were succeeding, however with a lower average grade than regular students (See **Table 6** for averages). The pass rate of the 47 students enrolled in Physics ELC was slightly better than the Chemistry ELC with a 72.1% pass rate with a similar average grade; however, if the students were taking both Physics and Chemistry ELC (25 students) their chances of success were better than all the ELC groups. This group had an average pass rate of 80.0% and also had a higher average grade.

Table 7. Pass Rates of Introductory Chemistry NYA for the 2001 and 2004 Cohorts.

Profile (Group)	Failures	Pass	Total	% Pass Rate
Chem. ELC	17	35	52	67.7%
Phys ELC	13	34	47	72.1%
No Chem. ELC nor Phys ELC	44	299	343	87.6%
Both Chem. ELC and Phys ELC	5	20	25	80.0%
Total	79	388	467	82.6%

4.4 Performance in Chemistry NYB

Chemistry NYB is normally taken in the second semester along with Physics NYC and Calculus NYB. Comparison of the grades in Introduction to Chemistry Part II (Chemistry NYB) for the 2001 and 2004 cohorts of the Chemistry ELC remedial and regular students demonstrated that the mean scores for all groups was 61.5% (SD ranging from 6.1 to 18.8) **(see Table 8 below and APPENDIX 9** for box plots of individual cohorts). The 30 Chemistry ELC students were within this range having mean grades of 57.6% (SD = 15.1 – 18.8) whereas the regular group (276 students) had a mean score of 71.3% (SD = 14.4 -18.8). For the 37 students enrolled in ELC Physics the mean score was 60.7% (SD = 7.2 -17.1). Those students who were enrolled in both Chemistry ELC and Physics ELC (21 students) had a mean score of 58.70% (SD = 6.1).

Table 8 Summaries of Mean Grades in Chemistry NYB for the Fall 2001 and Fall 2004 Cohorts

Group	Mean	N	Std. Deviation range
No Remedial	71.3	276	14.4 - 18.8
Chem NYA remedial	57.6	30	15.1 - 18.8
Phys NYA remedial	60.7	37	7.2 - 17.1
Both Chem and Phys	58.7	21	6.1
Weaker No Remediation	52.4	7	14.8
Total	61.5	170	6.1 – 18.8

The 7 weaker non-remedial students from the 2001 cohort who had below 80% High School entrance scores fared the poorest with a mean average of 52.4% (SD = 14.8) (see **Table 9**). The patterns of the spread of the grades had a similar comparison similarly with the results of the performance in Introduction to Chemistry Part I, the data indicated that the regular students had the highest overall average, 72.0%. Also, the students who took only Physics ELC performed better than both those who were enrolled in Chemistry ELC and those who were enrolled in both ELC groups (See **Table 3**). **Figure 7**, Box Plot 5 is an example of the grade distribution for the 2001 cohort.

Table 9 Summary of Mean Grades by Group for the Fall 2001 Cohort

Group	Mean	N	Standard Deviation
No Remedial	72.0	149	14.4
Chem NYA remedial	56.8	14	15.2
Phys NYA remedial	56.3	24	17.1
Both Chem and Phys	51.0	14	6.1
Weaker No Remediation	52.4	7	14.8
Total	67.1	208	16.6

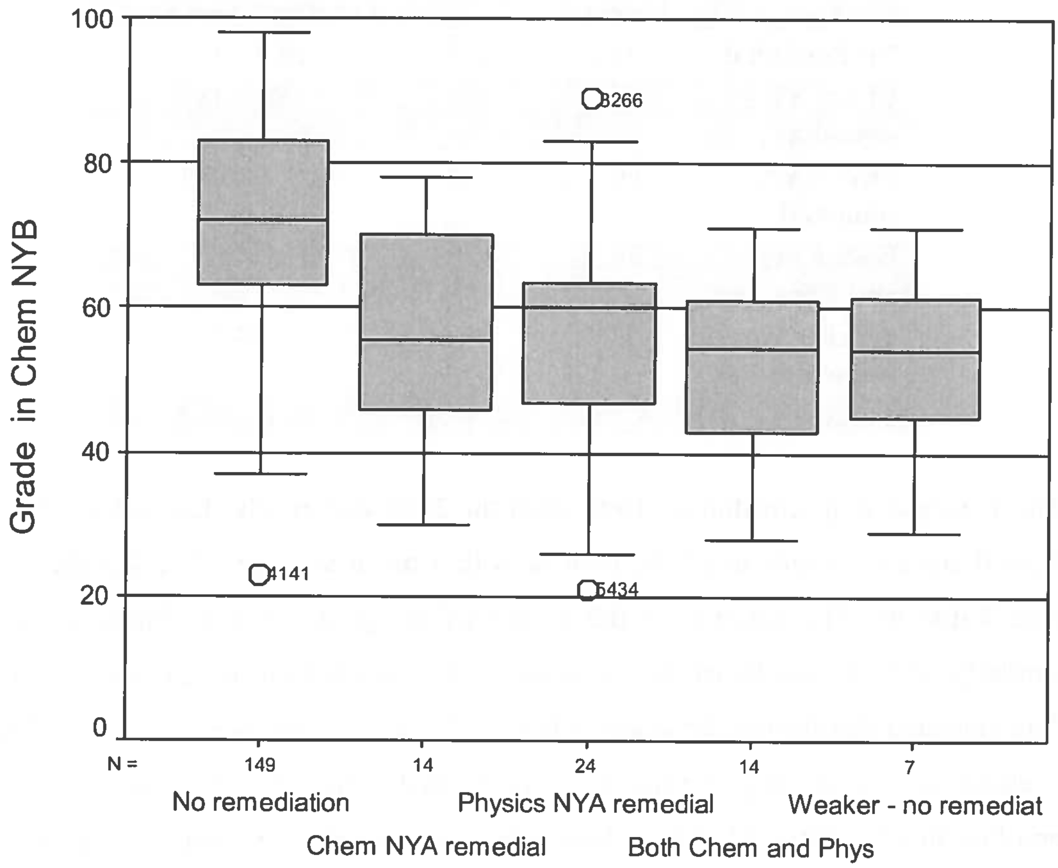

Figure 7. Chemistry NYB grades for the 2001 Cohort as a Function of the groups.

Box Plot 5 represents the range of the Chemistry NYB grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physics NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physics); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

The pass rate of the 285 regular students in Introductory Chemistry NYB was 86.5% whereas those 30 students enrolled in ELC Chemistry was 49.6% (see **APPENDIX 10** for individual cohorts). Less than half of these ELC students succeeded, however they had a significantly lower than the average grade when compared to the regular students. The pass rate of the 36 students enrolled in Physics ELC was significantly better than that of Chemistry ELC who had a pass rate of 72.2%. In other words, the students in the ELC Chemistry were still experiencing difficulty in Chemistry even though they had extra class time. The 21 students who took both ELC Physics and Chemistry performed better than ELC Chemistry and had a pass rate of 60.7 % (see **Table 10**).

Table 10: Pass Rates of Introductory Chemistry NYB by Group for the Fall 2001 and 2004 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	15	12	10	40
% Failure Rate	50.4	27.8	39.3	13.5
Pass with grade 60%-69%	7	17	7	75
% Pass grade 60%-69%	22.8	52.0	35.7	26.4
Pass grade 70-100%	8	7	4	170
% Pass grade 70-100%	26.8	20.2	25.0	60.1
% Overall Pass Rate	49.6	72.2	60.7	86.5
Average Grade	58.6	60.7	65.1	72.6
Total Students	30	36	21	285

4.5 Performance in Physics NYA

Physics NYA is normally taken in the first semester along with Chemistry NYA and Calculus NYA. **Figure 8**, Box Plot 6 **and Table 11** below illustrate an example of the variance in the Physics NYA grades for the 2004 cohort as a function of the section the students were placed. The ELC section (Section #243) had a mean score of 67.2% (SD = 13.5) compared to a mean score of 69.2% for the regular students' average score. Interestingly, there was one section (Section 210) that performed less favorably than ELC section with an average score of 61.9%. This suggests that having extra time given to less prepared students was a benefit. However, substantiation of this evidence is difficult because of the possibility of extraneous effects in section #210 such as scheduling or teacher effects. Similar trends of performance were observed for the 2001 cohort **(See APPENDIX 11).**

Table 11 Average Physics NYA Scores by Section for the Fall 2004 Cohort

File Number	Mean	N	Std. Deviation
210	61.9	27	11.8
228	77.3	35	13.3
231	70.7	33	17.0
236	68.8	33	16.1
239	70.2	34	13.1
243 ELC	67.2	35	13.5
252	70.5	34	15.5
256	64.7	36	15.4
Total	69.23	267	15.031

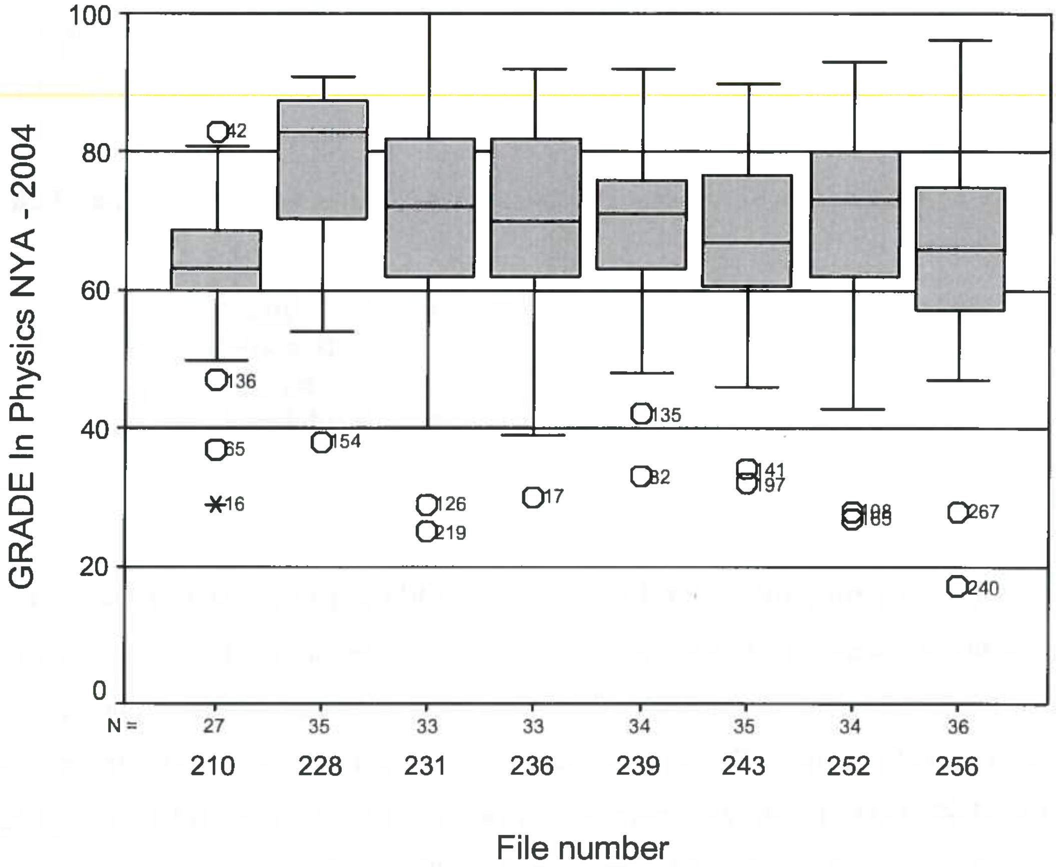

Figure 8. Fall 2004 Physics NYA Grades by Section

Box Plot 6 represents the median grade and range of all sections of Physics NYA for the 2004 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. File number 243 is the ELC section. All remaining file numbers are the regular students.

Comparison of all grades in Physics NYA for the 2001 and 2004 cohort for the regular students was 68.0% with the standard deviation for both years ranging from 11.7 to 17.7. The ELC students scored lower with an overall average of 64.2% (**see Table 12**).

Table 12 Summaries of Averages Physics NYA Grades for Fall 2001 and Fall 2004 Cohorts

Group	Mean	N	Std. Deviation Range
ELC	64.2	72	13.5 -16.1
Regular Students	68.0	454	11.7-17.7

Analysis by group of the 2001 cohort (see **Table 13**) revealed that the 17 remedial students registered in the Chemistry ELC group were below the average cohorts and had mean grades of 51.1% (SD = 15). This group was the weakest compared to all of the remedial groups. For those 32 students enrolled in ELC Physics the mean score was 61.9% (SD =15.8). The 16 students who were enrolled in both Chemistry ELC and Physics ELC performed slightly better than the Physics ELC group having a mean score was 62.9% (SD = 14.2). As expected, the regular group (178 students) had the highest overall average of 71.6% (SD = 16.6).

Table13. Summary of Mean Grades in Physics NYA for the Fall 2001 Cohort

Group	Mean	N	Std. Deviation
No Remedial	71.6	178	16.6
Chem NYA remedial	51.1	17	15.0
Phys NYA remedial	61.9	32	15.8
Both Chem and Phys	62.9	16	14.2
Weaker no Remediation	50.8	16	17.6
Total	67.2	259	17.7

An example of the mark distribution as a function of the group for the 2001 cohort is illustrated in **Figure 9**, Box Plot 7. It appears that the Chemistry ELC students performed as poorly as the weak non-remedial students. This trend was also observed in the 2004 cohort (See **APPENDIX 11**).

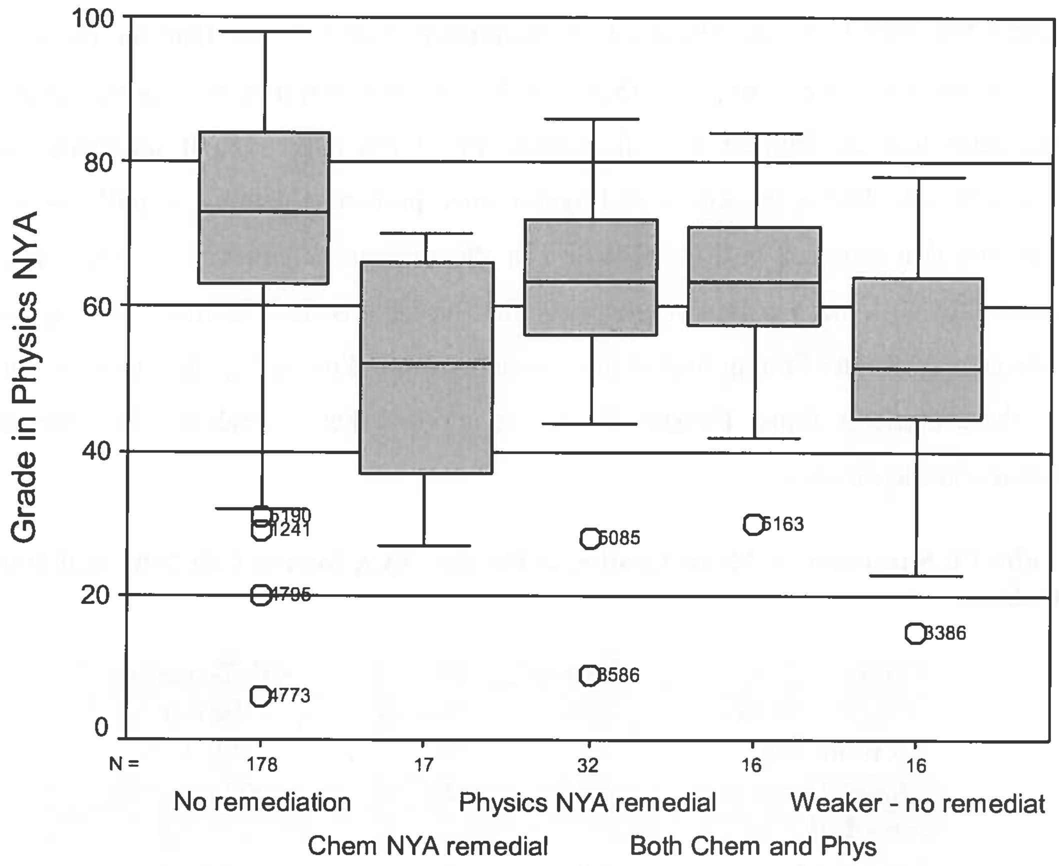

Figure 9. Performance in Physics NYA 2001 Cohort as a Function of the Groups.

Box Plot 7 represents the Physics NYA grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physics NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physics); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

The tabulated summary of the 2001 and 2004 cohorts by group is shown in **Table 14**. Analysis by group revealed that the 45 remedial students registered in the Chemistry ELC group were below the average for all ELC students for the 2001 and 2004 cohorts having mean grades of 54.4% (SD ≈ 16). This group was the weakest when compared to all of the remedial groups. For those 52 students enrolled in ELC Physics the mean score was 63.9% (SD ≈ 16). The 28 students who were enrolled in both Chemistry ELC and Physics ELC performed slightly better than the Physics ELC group and had a mean score of 65.5% (SD ≈ 16). As expected, the regular group (322 students) had the highest overall average of 71.1% (SD≈ 15) It indicates that the students who had a weakness in Physics only performed almost equally as well as students that required both remediation in Physics and Chemistry. The spread of the grades for both these groups was also similar. Notable is the Chemistry ELC group had a large dispersion of the grades with a median score below 60 %. This implies that most of these students failed Physics NYA. It appears that a weakness in Chemistry is echoed in the Physics.

Table14. Summary of Mean Grades in Physics NYA for the Fall 2001 and 2004 Cohorts

Group	Mean	N	Std. Deviation Range
No Remedial	71.1	322	14.9-16.6
Chem NYA remedial	54.4	45	15.-17.1
Phys NYA remedial	63.9	52	15.8-16
Both Chem and Phys	65.5	28	14.2-20.6
Weaker no Remediation	52.4	7	17.6
Total	61.5	463	14.2-20.6

The pass rate of the 340 regular students in Physics NYA was 84.25%, slightly less than the pass rates in Chemistry NYA (90.2%). The pass rate for those 45 students enrolled in ELC Chemistry was 53.9%. A little more than half of these ELC students succeeded, however they had a significantly lower than the average grade when compared to the regular students, 54.4% vs. 70.3%. The pass rate of those students enrolled in Physics ELC (50 students) and the 28 students that took both ELC Chemistry and Physics was significantly better than that of Chemistry ELC that had a pass rate of 80% and 75 % respectively. In other words, the students in the ELC Chemistry experienced difficulty in Physics even though they had the prerequisite High School grade in Physics. (see **APPENDIX 13** for individual cohorts and see **Table 15**). Similar patterns of pass rates were also observed in Chemistry NYB (see **Table 10**).

Table 15. Summary Table of the Pass Rates in Physics NYA by Group for the Fall 2001 and 2004 Cohorts.

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	20	13	7	52
% Failure Rate	46.1	25	25	14.85
Pass with grade 60%-69%	17	17	9	87
% Pass grade 60%-69%	37.3	34	31.25	25.9
Pass grade 70-100%	8	20	12	197
% Pass grade 70-100%	16.6	40.85	43.75	58.25
% Overall Pass Rate	53.9	74.9	75	84.2
Average Grade	54.4	64	65.5	70.3
Total Students	45	50	28	340

4.6 Performance in Physics NYB

Students normally take Physics NYB in their third semester along with Biology NYA and the Health Science profile students would also be taking Organic Chemistry BLC. The data below demonstrates the performance of ELC students as a function of which ELC classes they were placed in their first semester courses, as described earlier. It also describes the performance of regular students and those who were weak and did not benefit from any remediation in their first semester. Students enrolled in Physics NYB in the Fall 2002 was analyzed in terms of the Fall 2001 cohort and the Fall 2004 cohort took Physics NYB in Fall 2005 provided that the students were on profile. The statistical data represented by box plots for these two cohorts is given in **APPENDIX 14.**

The 16 remedial students registered in the Chemistry ELC group had averages below those of other ELC groups and had a mean grade of 57.5% (SD ranging from 7.2 to 15.1) for the 2001 and 2004 cohorts. The 21 students who were enrolled in both Chemistry ELC and Physics ELC performed similarly with a mean score of 58.6% (SD range 6.1 to 13.2). For the 37 students enrolled in Physics ELC, the mean score was 60.6% (SD ≈ 16). As expected, the regular group (276 students) had the highest overall average of 72.3% (SD range 10.4 to 14.3). The weak non-remedial group that had only 7 students on profile scored the lowest with an average of 52.4%. The results are tabulated in Table **16**.

Table 16. Summary of Mean Grades in Physics NYB for the Fall 2001 and 2004 Cohorts by Group

Group	Mean	N	Std. Deviation Range
No Remedial	72.3	276	14.3 – 10.4
Chem NYA remedial	57.5	30	7.2 – 15.1
Phys NYA remedial	60.6	37	7.2 – 17.2
Both Chem and Phys	58.6	21	6.1 – 13.2
Weaker no Remediation (2001 cohort only)	52.4	7	14.7

An example of the mark distribution as a function of the group for the Fall 2004 cohort is illustrated in **Figure 10**, Box Plot 8 and summarized in **Table 17**. It indicates that the students who had a weakness in Physics performed almost equally as well as students that required both remediation in Physics and Chemistry. This pattern was also observed in Physics NYA, in that, the spread of the grades for both these groups were also similar. Notable was the Chemistry ELC group that had a large dispersion of the grades with a median score at 60 %. This implies that half of these students failed Physics NYB. It appears that a weakness in Chemistry again was echoed in the Physics NYB. This trend was also observed in the 2001 cohort (See **APPENDIX 14**).Also noteworthy was the absence of grades for those weak students who did not have remediation at all. None of these 2004 cohort students remained on profile and had either continued in the Science Program, switched programs or had dropped out of the college.

Table17. Summary of Mean Grades in Physics NYB for the Fall 2004 Cohort

Group	Mean	N	Std. Deviation Range
Regular students No Remediation	72.6	163	10.4
Chem NYA remedial	58.4	16	18.8
Phys NYA remedial	65.0	13	7.2
Both Chem and Phys	66.3	7	6.0
Weaker no Remediation (2004 cohort only)		none	

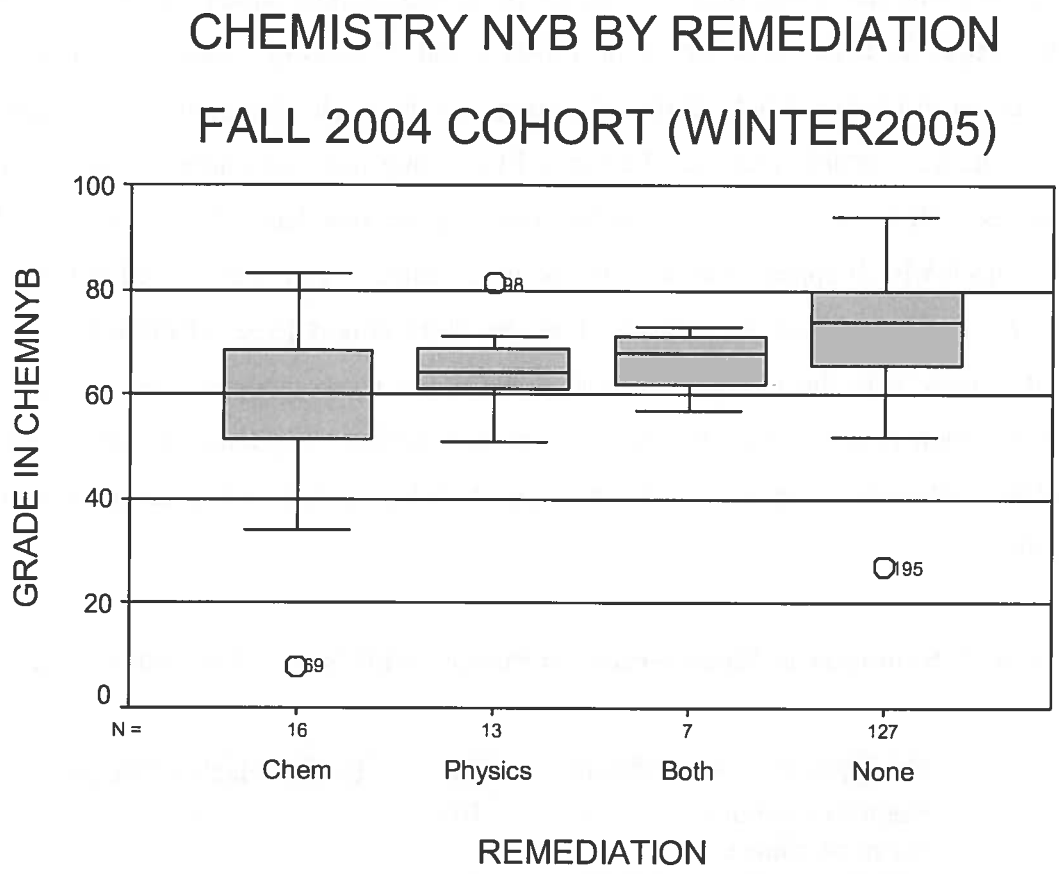

Figure 10. Grades in Physics NYB Fall 2005 (Fall 2004 Cohort)

Box Plot 8 represents the range of the Physics NYB grades in Fall 2005 for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physics NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physics); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

4.7 Performance in Biology NYA

Students normally take Biology NYA in their third semester. The comparative analysis of the grades in Biology NYA for the Fall 2001 and Fall 2004 cohorts (327 students) combined with Chemistry ELC remedial and regular students demonstrated that the mean scores for all groups was 80.1% (SD range 5.3 – 17.7). The 28 remedial students registered in the Chemistry ELC group were below this average having average grades of 69.4% (SD ranged from 5.3 to 17.7). This group was the weakest when compared to all of the remedial groups. There was a variance of ability within the groups as evidenced by the spread of the grades. It appears that a weakness in Chemistry was echoed in the Biology results as well. Those students (26 students) enrolled in ELC Physics the mean score was 76.8% (SD ≈ 8) and those 16 students who were enrolled in both Chemistry ELC and Physics ELC performed slightly lower than the Physics ELC group having a mean score of 74.3% (SD ≈ 5.5). The achievement of the students within each of these groups was fairly similar as indicated by the spread of the grades within these two groups. As expected, 246 students registered as the regular group had the highest overall average of 82.8% (SD≈ 7) (See **Table 18 and APPENDIX 15**). The 7 weak students who did not have any remediation performed the poorest with 65.2% average score (SD range 6.7 – 17. 7). This group also had students ranging with significantly different abilities/grades within this group.

Table 18. Summary of Mean Grades in Biology NYA for the Fall 2001 and Fall 2004 Cohort

Group	Mean	N	Std. Deviation
Chem NYA remedial	69.4	28	5.3 - 17.3
Physics NYA remedial	76.8	26	7.3 - 8.7
Both Chem and Phys	74.3	16	5.3-5.7
No remediation	82.8	246	6.3-8.2
Weaker – Non - Remedial	65.2	7	6.7-17.7
Total	80.1	327	5.3 – 17.7

An example of the mark distribution as a function of the group for the 2001 cohort is illustrated in Figure 11, Box Plot 9 and summarized in **Table 19**. It indicated that the 14 students who had a weakness in Physics only (Physics ELC) had an average score lower that the regular students with an average of 76.4% (SD = 8.2) when compared to the 131 regular students who had an average of 83.2% (SD = 8.7). This implies that Physics remediation may be helping these students or that these students posses certain abilities and/or attitudes that help them be successful in their other Science courses. However, if there is a weakness in Chemistry, as those in Chemistry ELC (14 students) who had an average of 65.4% (SD = 18.7) and also, the 8 students that required remediation in both Chemistry and Physics who had an average of 70.6% (SD = 5.3) then these students were also experiencing difficulty in Biology as in their other Science courses. The spread of the grades for the group of students taking both Chemistry and Physics ELC and the weak students who did not have remediation were similar as evidenced by the standard deviation. The few students who remained on profile were passing but were not doing as well as the regular students. Significantly is the Chemistry ELC group that had a large dispersion of the grades with a median score below ≈ 63 % (**APPENDIX 15**). At least 25% of these students failed Biology NYA. This trend was also observed in all the other Science courses analyzed. It appears that a weakness in Chemistry was also echoed in the Biology. This trend was also observed in the 2004 cohort (See **APPENDIX 15**). Also notable, was the performance of the Chemistry ELC students was similar to those weak students who did not have remediation at all.

Table 19. Summary of Mean Grades in Biology NYA for the Fall 2001 Cohort

Group	Mean	N	Std. Deviation
Chem NYA remedial	65.4	14	17.3
Physics NYA remedial	76.4	14	8.7
Both Chem and Phys	70.6	8	5.3
No remediation	83.2	131	8.2
Weaker – Non - Remedial	63.6	5	17.7
Total	79.9	172	11.2

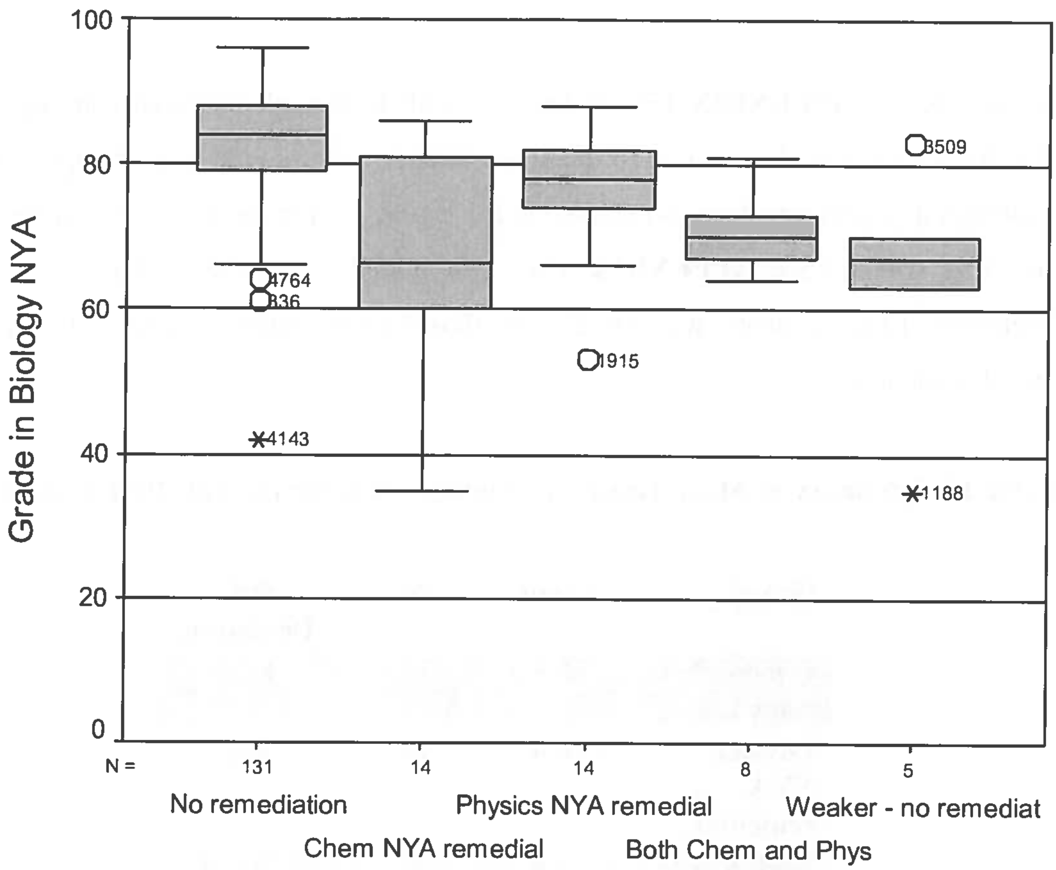

Figure 11. Grades in Biology NYA Fall 2002 (Fall 2001 Cohort)

Box Plot 9 represents the range of the Biology NYA grades in Fall 2002 for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physics NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physics); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC. It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

The pass rate of the 258 regular students in Biology NYA was 92.8%.This passing rate was the highest when compared to all of the Science courses in the Science Program that have been discussed. The pass rate for the 28 students enrolled in ELC Chemistry was 69.7% which was significantly lower than the pass rate of the regular students which was 92.8%. The pass rate of those 25 students enrolled in Physics ELC and the 16 students who took both ELC Chemistry and Physics was found to be significantly higher than that of Chemistry ELC having a pass rate of 86.2% and 87.5 % respectively (see **APPENDIX 16** for individual cohorts and **Table 20** below). This pattern of pass rates were also observed in all other Science courses studied.

Table 20. Summary of Pass Rates of Biology NYA by Group for the Fall 2001 and 2004 Cohorts.

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	3	1	0	5
% Failure Rate	10.7	3.9	0	>1
Pass with grade 60%-69%	9	4	4	13
% Pass grade 60%-69%	32.2	16.4	25	5.1
Pass grade 70-100%	16	20	12	247
% Pass grade 70-100%	57.15	79.8	75	95.6
% Overall Pass Rate	69.7	86.2	87.5	92.8
Average Grade	69.4	76.9	74.3	82.0
Total Students	28	25	16	258

4.8 Retention of Science Students

The analysis of students that remained on profile demonstrated that the regular and Physics ELC students had similar results after their 2nd semester whereby approximately 80% of these students were on profile. The Chemistry ELC and the weaker non-remedial students had the lowest percentage on profile after the second semester having 57.7% and 46.7%, respectively. (See **Table 21**). There was a significant difference in the those students on profile after the 3rd semester in that 65.5% of the students were on target compared to 26% for the Physics ELC and Chemistry ELC students determined by the Physics NYB enrolment. Surprisingly, a greater number of the students requiring remediation in both Chemistry and Physics remained on profile in both Biology NYA and Physics NYB.

Table 21. Summary of Students on Profile for the 2001 and 2004 Cohorts.

Course and Semester	Group	Initially Registered	Total Number of Students on Profile	% on Profile
CHEM NYB				
2nd Semester	No Remedial	326	276	**84.7**
	Chem NYA remedial	52	30	**57.7**
	Phys NYA remedial	47	37	**78.7**
	Both Chem and Phys	26	21	**80.8**
	Weaker No Remediation	15	7	**46.7**
Physics NYB				
3rd Semester	No Remedial	322	211	**65.5**
	Chem NYA remedial	45	12	**26.7**
	Phys NYA remedial	52	14	**26.9**
	Both Chem and Phys	28	11	**39.3**
	Weaker No Remediation	16	0	**0.0**
Bio NYA				
3rd 'Semester	No Remedial	326	252	**77.3**
	Chem NYA remedial	52	28	**53.8**
	Phys NYA remedial	47	26	**55.3**
	Both Chem and Phys	26	16	**61.5**
	Weaker No Remediation	15	5	**33.3**

The distribution of the Science students by program for the Fall 2001 and 2004 cohort was examined and the results were tabulated in **Table 22**. The semesters targeted were those of the expected time of graduation. Winter 2003 semester was selected for the 2001 cohort and Winter 2006 for the 2004 cohort. Less than half of the students (40.4%) who took Chemistry ELC (52 students) persisted in the Science Program after 4 semesters. The remaining 51.9% switched to other programs in the college. Only

7.7% dropped out of college or transferred to another college. The retention in Science for the 28 weaker non-remedial students revealed that these weak students also had a low retention in Science, 42.9% that paralleled the in ELC Chemistry group, 40.4%. Additionally, the weaker non-remedial students had a larger tendency to drop out of the college with a 21.4% abandoned rate. There were 47 students who took Physics ELC, 61.7% remained in the Science Program, 27.7% switched to other programs and 10.6% abandoned the college. The 18 students who took both Chemistry ELC and Physics ELC had 72% retention in Science, 20% who switched programs and 8% who abandoned the college. All the ELC groups demonstrated lower retention rates in the Science Program than the regular student who had 76.3% retention. Only a small majority of them, 12.7% switched programs. However, the abandoned rate was higher when compared to other groups, 11.1%. The data indicates that a student that was weaker in Physics than in Chemistry was more persistent in the Program. The data for the graduation rate was not available. However, the assumption was made that if a student has persisted in a program for 2 years, then it is conceivable that he/she eventually graduated in the program. It appears that the ELC students particularly those who have ability in Chemistry, based on their High School incoming grades, are motivated and stick to the program. Most of the students who switch programs opted for the Commerce Program.

Table 22. Summary of the Distribution of Students for the Fall 2001(Winter 2003) and Fall 2004 cohorts (Winter 2006).

PROGRAM	GROUP				
	Regular Students	Chemistry ELC Students	Physics ELC Students	Both Phys & Chem	Weaker Non-Remedial
Science	241	21	29	18	12
Social Science	8	14	5	1	1
Commerce	25	9	6	3	7
Creative Arts	1	2	0	1	1
Liberal Arts	2	1	0	0	0
Accounting and Management Tech.	2	0	0	0	0
Publication Design and Management	2	0	0	0	0
Computer Science Technology	0	1	2	0	1
DROPPED OUT OR TRANSFERRED	35	4	5	2	6
TOTAL REMAINING	281	48	42	23	22
INITIALLY REGISTERED	316*	52	47	25	28
RETENTION IN SCIENCE	76.3	40.4	61.7	72.0	42.9
RETENTION IN OTHER PROGRAMS	12.7	51.9	27.7	20.0	35.7
% ABANDONED	11.1	7.7	10.6	8.0	21.4

*35 students transferred into Science during the academic years of 2001 and 2004.

CHAPTER 5
DISCUSSION AND CONCLUSION

The transition to college studies has always been of particular interest to teachers, school administrators and researchers in higher education. This field of interest is multifaceted and extensive. However, the many areas that influence students' first year college experiences and successes still require investigation. For example, factors that relate to socio-economic, psychological and academic backgrounds all impact this transition (Goldrick-Rab, S., 2007). This *ex post facto* descriptive comparative study focused on the impact of remediation on under prepared High School Science students. Specifically, this research examined the performance of these less prepared students in comparison to those who had the necessary pre-requisite High School grades. The aim of this longitudinal study was to determine whether remedial courses in introductory Physics and Chemistry courses were beneficial in terms of academic success. It also studied the retention rate within the Science Program and the college in general. As expected, there was a correlation between extra class time and success in the courses when compared to those who were less prepared and did not have the support of remediation. However, a major finding was that students who displayed a weakness in Chemistry experienced lower grades and pass rates in all their college Science courses. Another significant finding was that a majority of these less prepared students, despite the fact that they were experiencing difficulty, continued to persist in the Science Program.

The scope of this research was to examine the performance of students as they moved through the Science Program keeping in mind their level of preparation (prior knowledge) and whether additional support through extra class time was beneficial. It is important to note that student performance was based on the grades they earned in their introductory Science courses, a numerical score that is not necessarily indicative of their understanding of the material. There are many factors that contribute to student outcomes. These factors include: preparation for examinations, time required for learning and assessments, the ease of in-class tests, the effectiveness of the teacher, and student attitudes and motivation. In this study two factors were considered: in-class time and the equity of the assessments used when compared to the assessments used in other sections.

To authenticate that the performance results were consistent and not particular to any given group of students, several cohorts were studied. The large sample of students within these cohorts experienced different learning environments such as time of day of the course offering, various teachers and teaching styles and different group dynamics. Therefore generalizations regarding patterns and the trends were not specific to any given cohort. Also, in order to assure that the findings of this study were valid, it was necessary to determine whether the introductory Science courses that these less prepared students took were coherent with other sections of the same course, and that the only variable was the actual time spent in class. This was ascertained through the results of a recent study on curriculum coherence conducted at this college which the author had first hand experience as a co-researcher (Bateman, Taylor, Janik & Logan, 2008).

5.1 Background and Coherence

The courses offered in all CEGEP Science courses are basic introductions to the disciplines. At this level, most students do not possess an in-depth knowledge of the disciplines and therefore, the recall of information, practical applications and some limited analysis of observed phenomena within the discipline were the focus of the learning outcomes in the introductory courses.

In most Science departments, a comparable grading scheme, common course objectives, and in some cases, common final exams are used in multi-section courses. In order to determine the coherence across various sections of the same course, an analysis of the course outlines indicated that the stated objectives and topics covered were identical for all multi-section courses in all of the Science courses. However, there was a slight variance in the assessment schemes. Generally, final grades for courses consisted of two or three class tests and quizzes. In Chemistry and Physics, each course had a laboratory component weighted as 15% and an Integrative Activity worth 5%. In Chemistry and Biology a common final exam, covering the entire course, was graded using a common marking process in order to ensure equity in the grading of the assessments given. The common marking system required that each teacher grade a section of the exam for all students taking the course. In addition, the final course grade was based on a flexible grading option. For example, Chemistry had the option that the final exam could weigh no more than 50% but no less than 30%. This grading scheme was particular to each student depending on which ever was more advantageous to the student. The grading option in Biology courses was such that the laboratory component was weighted at 30% and a student had to the pass assessments given on the theory component, given in class, in order for the laboratory component to count towards the final grade. Physics had the least coherent grading system since there was a difference in the number of tests that were given in some sections and not all teachers gave a final examination. However, this was not viewed as problematic since the number of assessments in the Extended Lecture Classes was within the norm of the department and a final exam was given to these students.

The most common instructional strategies used was formal lecturing, in class discussions, and problem solving sessions where students had the opportunity to work cooperatively. The Extended Lecture Class had more time to be actively involved in these activities.

Laboratory work, which included the use of a laboratory manual, was common in all sections of the same course in each of the Science disciplines. The learning outcomes of the experiments were coordinated with theoretical material so that the topics taught in class were reinforced in the laboratory. This teaching approach offered practical applications of the theory learned in class and an opportunity to improve oral communication skills in Science.

In all of the Science disciplines, a common textbook was used for the multi-section courses. The teachers of the Science disciplines remarked that the students mostly used the textbook as a reference, for assigned readings and the problem sets were assigned for practice. In most of the Science courses, the teachers designed course manuals to support their teaching style.

The alignment within multi-section courses was based on the types of knowledge required by students and the cognitive complexity according to Bloom's

Taxonomy. This data was gathered from a previous study (Bateman, Taylor, Janik & Logan, 2008). It was reported that the intended learning outcomes for Chemistry NYA and level of difficulty of the assessments between the different sections offered were coherent and aligned. It was found that there was a preponderance of conceptual questions asked in the assessments. This predominance is appropriate since Chemistry NYA is more focused on descriptive Chemistry with less of an emphasis on mathematical reasoning. Therefore, it can be presumed that the courses that were given to the ELC groups were not easier or more difficult than other sections offered. The only difference was that the ELC students had more in-class time. The cognitive complexity of the introductory Physics course was reported to have most of the assessments requiring procedural knowledge since there was a heavy emphasis on problem solving. In the introductory Biology course, the students were primarily required to recall factual knowledge in class assessments and were required to use conceptual procedural knowledge in the laboratory.

In this same study on curriculum alignment, the cognitive complexity of multi-section courses was examined. Analysis of the cognitive complexity of the assessments in introductory Chemistry courses revealed that a majority of the grade was attributed to application type questions. It was not surprising that a large proportion of the mark required the student to apply knowledge since a major component of Chemistry NYA focused on chemical equation writing. There was a small difference for the ELC group which reported to have fewer marks awarded for assessments that required the application of knowledge when compared to other sections of the same course. However, the mark value for assessments that required that the students carry out analysis, which is deemed to be more difficult than application according to Bloom (1964), was slightly above the average for the ELC group. Thus, this imbalance of fewer assessments that required application versus more assessments that required analysis supports an assumption that the ELC classes were challenged intellectually at a level that was comparable to other sections. This supports the assumption that the competencies addressed in the Extended Lecture Classes were the same as regular classes and that the only difference was that these students were given extra in-class time.

5.2 Profile of Incoming Students

Current research in the preparation for college is extensive (Goldrick-Rab, 2007). Research has shown that High School performance is a strong predictor of subsequent college performance (Nora & Rendon, 1990b; St. John, 1991; Thomas, 1998). The profile of the incoming ELC students' High School grades revealed that these students had similar incoming averages for the two cohorts studied. Analysis of other cohorts that were not extensively studied in this research also exhibited similar patterns. These students all had less than 80% in their overall incoming High School average. The ELC students were significantly weaker than the regular students. However, in the comparison of the spread of High School entrance scores as a function of the ELC Chemistry NYA and Physics NYA section that they were registered, gave little variability within this group. This implies that the college selected only the "best" under prepared students and limited the course offerings to only one section offered per semester; otherwise, there could have been more sections of ELC offered to students whose incoming averages were substantially lower than the required 80%. It is assumed that some restrictions to admission to the ELC were applied and that not all students who applied were admitted. Comparison of the spread of the incoming High School grades for the ELC students and the regular students demonstrated that there were consistent patterns for the 2001, 2002, 2003, 2004 and 2005 cohorts. Although the 2002, 2003 and 2005 cohorts' performance in subsequent courses was not studied, the conclusions and findings for the 2001 and 2004 cohorts can be generalized to these cohorts since similar characteristics were exhibited in their college preparation. Moreover, the disciplines studied demonstrated that the courses offered were coherent across sections of the same course (Bateman, Taylor, Janik & Logan, 2008) and therefore the ELC students had similar learning objectives at the same level of difficulty as all the other Science students. The remainder of this discussion will focus on the 2001 and 2004 cohorts since these groups were analyzed in detail due to the availability of data.

5.3 Performance in College Level Courses

A comparison of the performance in college level courses of regular students, weak non-remedial students whose incoming High School average was less than 80% and also had less than 65% in Chemistry NYA and the ELC students was studied. The ELC students were subdivided into categories that took into consideration whether the students had a weakness in Chemistry and/or Physics. The weak non-remedial students were also selected as a group in order to compare the performance of these weak students with students who had extra class time. In other words, this group functioned as the control group since they had characteristics similar to the ELC groups. Analysis of the High School grades as a function of which ELC group (class) the students were in revealed that those students who were placed only in the Chemistry ELC, as well as, those students who were placed in both Chemistry ELC and Physics ELC were slightly less prepared than those students who were placed only in the Physics ELC. The weaker non-remedial students had the lowest incoming High School grades. It is not known why these students were not placed in any remedial classes offered. It is possible that these students may have had the pre-requisite 70% in their High School Chemistry and Physics courses but had lower overall grades in their other High School courses. Another possible reason might have been that some of these weak students could have been foreign students whose prior knowledge could not be verified by the college. If that was the case, then the college should have erred on the safe side and placed them in the ELC courses. The reasons for the placement of the non-remedial weak students were not investigated as it was beyond the scope of this study.

5.3.1 Performance in Chemistry NYA

Chemistry NYA, "Introduction Chemical Bonds and States of Matter", is the first compulsory Chemistry course in the Science Program and is normally taken in the first semester. It deals with the structure and properties of matter and its transformations. The aim of this course is to examine the link between the structure of matter and its properties. It therefore develops concepts fundamental to the learning of

Chemistry. The course content incorporates laboratory exercises, which serves to clarify theoretical aspects and to provide exposure to several traditional techniques of experimental Chemistry. Some portions of the course material are developed in a mathematical context but the focus is primarily descriptive Chemistry. The knowledge and skills developed in this course are required for further studies in Chemistry, and other Science courses in the program. The goals of instruction are to acquire domain specific knowledge and foster problem solving skills within this domain (Heyworth, 1999). Oftentimes students will experience learning difficulties depending on their maturity, ability, motivation, attitudes, learning styles and prior knowledge.

The performance of all students in a multi-section offering of Chemistry NYA, as a function of which section the students were placed, afforded some expected, as well as, some surprising results. There was a strong correlation between the average grades in Chemistry NYA and the average High School grade when analyzed by section. As anticipated, those sections that entered the program with high entrance scores performed better than those sections that had lower incoming grades. This finding is consistent with the literature discussed previously (Nora & Rendon, 1990b; St. John, 1991; Thomas, 1998) that past performance is the best predictor of future performance. Also expected was the finding that the incoming High School grades were significantly higher than the first semester college grades. The distribution of the grades was much more spread out for Chemistry NYA compared to the range of High School average grades. The most likely reason for this tight clustering of High School grades is due to the admission requirements of 80% minimum to enter the Science Program. As a result, the variance in the High School grades was relatively small. However, it was noted that there was a significant variation of median grades for Chemistry NYA in the different sections. It was found that most of the ELC students passed Chemistry NYA; however, a large majority of them were marginally passing with grades in the 60-70% range. The majority of regular students had passing averages in the 70-90% range. Although the majority of these ELC students succeeded, they were still experienced difficulty in learning Chemistry. The variance between sections of Chemistry NYA could be explained by other factors. For example, teacher effects, group dynamics and the time of day that the course is being offered are some of the most common factors that can influence class performance. This investigation did not include the analysis of these variables.

A somewhat surprising finding was that one regular section in each of the two cohorts studied had a large proportion of weak students with less than 80% in their High School average and had performed comparably to the ELC students in Chemistry NYA when analyzed by section. This may suggest that having extra time given to less prepared students may not have an effect in improving performance. However, this evidence may be biased since the sample size of these sections of weak non-remedial students was small. In addition, these students were placed in sections that had fewer students than the norm and therefore may have been subjected to extraneous effects such as benefiting from a small class size.

The analysis of performance as a function of which ELC group the students were placed, as described earlier, paralleled the observations in the performance by section. As expected, those regular students who had the prerequisite High School entrance scores performed substantially better with higher pass rates than those in the ELC groups. However, there were some differences observed in the average grades of the different ELC groups. Those students who required Chemistry ELC performed slightly better in Chemistry NYA than those who only took Physics ELC. Both groups had similar pass rates in their Chemistry NYA course. Therefore, Chemistry ELC is effective in helping less prepared students be more successful. However, those students who required both Chemistry ELC and Physics ELC performed the poorest. Although most of these students succeeded, they only marginally passed Chemistry NYA. The results of the analysis of the performance of the weak non-remedial students as a group that originated from several sections of Chemistry NYA revealed that they had the lowest mean score than any group and therefore, a larger polarization among those who have remediation or are in the regular group. This evidence suggests that remediation did help the weaker students especially since these weak non-remedial students were spread out over several sections and therefore extraneous effects such as scheduling, class size or teacher effect was not a factor. This is contrary to the observation of performance by section whereby the non-remedial weak students did better than the

Chemistry ELC students. The most probable explanation is that the anomalous weak non-remedial sections benefited from the low class size.

5.3.2 Performance in Chemistry NYB

Chemistry NYB, "Introduction Chemistry of Solutions", is the second and final compulsory Chemistry course in the Science Program. It is normally taken in the second semester. Students in the Health Science Option would take Organic Chemistry I (Chemistry BLC) in their third semester. The purpose for studying solution Chemistry is to acquire a qualitative and quantitative understanding of matter that is as common to daily life as it is to the chemical laboratory. In this course, the student is required to apply the knowledge and skills attained previously in Chemistry NYA. The course content incorporates laboratory exercises, which serve to illuminate theoretical aspects and to provide exposure to several standard traditional techniques of experimental Chemistry. Chemistry NYB, deals with some quantitative aspects of chemical reactions occurring in solution, thus relies on various aspects of Mathematics and Physics.

The analysis of the performance in Chemistry NYB for the 2001 and 2004 cohorts of the Chemistry ELC remedial groups and regular students indicated that the mean scores for all groups were lower in this course when compared to the Chemistry NYA average scores. The content of this course is more challenging. It requires that the student apply mathematical algorithms and expand on Chemistry topics previously learned at the High School and CEGEP level. The course focuses on theoretical concepts and practical applications. Students are required to have a relatively strong background in High School Algebra in order to tackle the problem solving aspects of this course.

The students that experienced the most difficulty were the few non-remedial weak students that made it to Chemistry NYB. Most of them failed this course. It is important to note that these students did not have any additional support in Chemistry NYA. The Chemistry ELC group had a significantly lower mean grade when compared to the regular group. Almost half of the Chemistry ELC students failed their second semester course and those who did pass had a significantly lower average grade when compared to the regular students. The students who required only Physics ELC performed the strongest within the ELC groups. Therefore, the students that entered college with a High School Chemistry grade over 70% remained stronger than those who did not. This was also evidenced by the pass rate of those students enrolled in Physics ELC who had a significantly better pass rate than that of Chemistry ELC groups. In other words, the students in the Chemistry ELC were still experiencing difficulty in Chemistry despite the additional help of extra class time. Nakahleh (1992) hypothesizes that those students who experience difficulty to learn Chemistry lack the ability to construct understanding of the fundamental concepts from the very start of their studies. This inability results in a difficulty with more advanced concepts that build on fundamentals and requires the integration of the cognitive structures of chemical knowledge. Compounding this lack of understanding is the inherent obstacle of misconceptions that the learner has about chemical concepts that originate from their everyday experiences and their worldview (Nakhleh, M., 1992). The inability to think abstractly, more specifically symbolically is the primary barrier to understanding Chemistry (Johnstone, 1991b). In this second course in Chemistry, the students are required to frequently use mathematical symbols, formulas and equations to express relationships in both the micro-cosmic and macro-cosmic level. Students must use analogies and models that are associated with symbols. In order to do so, they require an imagination and a deep thinking process. If the learner has employed rote memory techniques as their primary learning strategy in previous courses, they eventually will not be able to function at a cognitive level required for success in Science, particularly Chemistry NYB. Therefore, a possible causal effect of poor performance by the Chemistry ELC student, even though they were given remediation in Chemistry, is that they never mastered the ability to problem solve and think abstractly. They probably continued to employ rote memory techniques that they used in their previous Chemistry courses just to get by. It would probably be beneficial to modify the Chemistry remediation course and not only provide extra time for in-class examples but also include a focus on developing learning strategies that will enable students to make conceptual sense out of chemical events. This would not only help them in their Chemistry courses but also in their other Science courses. Since the development of abstract thinking requires time, the college should consider remediation in Chemistry NYB as well.

Another factor that may have contributed to poor performance was prior mathematical skills. Each student's High School average was based on all Ministerial courses that included Mathematics. The requirement for admission to the Science Program was 70% in High School Mathematics. Studies have shown that success in secondary school Mathematics is a strong predictor of college performance (Tai, 2006). Perhaps this standard should be re-examined in light of the rigor of the Science courses. This aspect was not examined in terms of the ELC students in this research and merits further investigation.

5.3.3 Performance in Physics NYA

In Physics NYA, "Introduction to Mechanics," students are required to analyze different physical systems and phenomena using general principles of Physics as well as concepts of classical mechanics. Physics NYA is the first of three obligatory Ministerial Physics courses, which have to be taken by all students in the Science Program. Students usually take this course during the first semester concurrently with Calculus I (Differential Calculus) and Chemistry NYA. The role of the course in the program is two-fold. It presents the basic principles of mechanics — kinematics, dynamics, and the three conservation laws (energy, momentum and angular momentum) — which are essential to the study of all the natural Sciences. It also provides an opportunity for students to develop problem solving skills. In particular, students learn to use vectors to solve a variety of problems, and apply the techniques of differential calculus to Physics as they learn them in Calculus NYA.

Comparison of all grades in Physics NYA for the regular students as well as all remedial groups produced similar results as found in the Chemistry courses. The regular students out-performed the remedial students, as expected. The remedial students registered in the Chemistry ELC group performed the weakest compared to all of the remedial groups. The median score was below 60 % with the grades extensively scattered. This implies that many of these students failed Physics NYA. It was found that only slightly over 50% of these Chemistry ELC students were succeeding with significantly lower than the average grades when compared to the regular students. Moreover, their median averages were less than those who came in less prepared in Physics (Physics ELC). Also noteworthy, is that their performance was similar to academically under prepared students who did not have remediation at all. In other words, the students in the Chemistry ELC students experienced difficulty in Physics even though they had the prerequisite High School grade in Physics. This pattern was also observed in the pass rates for Chemistry NYB. It appears that a weakness in Chemistry is echoed in Physics. Unexplainably, the students who had a weakness in Physics performed almost equally as well as students who required both remediation in Physics and Chemistry. These two groups had a similar distribution of the grades with a significantly better pass rate than the Chemistry ELC students.

The pass rate and average grades for all students in Physics NYA was lower than the pass rate in Chemistry NYA. A possible reason for this is that Physics NYA requires strong skills in Mathematics that are developed in Mathematics courses at the college level. In a recent study, it was found that the intellectual demands of the Physics NYA oftentimes require a routine application of algorithms which encourages most students to use a surface approach to learning. First semester students will often take an approach of memorizing rather than understanding concepts (Dickie, 2003). This evidence supports the premise that those students who are strong in Mathematics can succeed in Physics NYA even thought they may posses a minimal conceptual understanding of the course material. The Physics ELC students may be doing better than the Chemistry ELC students in Physics even though they are weaker in Physics because much of the assessments were based on routine algorithms and they were able to apply less demanding cognitive skills. However, students who are weak in Chemistry were at extreme disadvantage because even though they had the pre-requisite Physics ability, their performance was significantly lower than the Physics ELC students. The students weak in Chemistry may be missing the intellectual skills that can help them succeed in Physics since a large proportion of Chemistry ELC students failed Physics NYA. The ability to think abstractly is required both in Chemistry and in higher level Physics in order to have a conceptual understanding of phenomena.

5.3.4 Performance in Physics NYB

Physics NYB, "Introduction to Electricity and Magnetism" is the third Physics course in the Science Program. This course is normally taken in the third semester. The content of the course is a survey of the fundamental laws of electricity and magnetism, leading up to their synthesis in Maxwell's Equations. The level of mathematics used is quite demanding since the students have completed the differential and integral Calculus courses by the time they enroll in this course. This course applies more abstract concepts compared to the Physics NYA because it deals with phenomena such as magnetic and electrical fields that are not visible to the naked eye. This abstract thinking is similar to that required in Chemistry.

As anticipated, all the ELC remedial groups performed similarly with average scores below those of the regular students. Similar to the results observed in the Chemistry NYA, Chemistry NYB and Physics NYA, the students who were enrolled in both Chemistry ELC and Physics ELC and only in the Physics ELC performed equivalently. They had slightly better results than the Chemistry ELC group. As observed in other courses, a weakness in Chemistry was again echoed in the Physics NYB probably due to the same reasons described earlier. The weak Chemistry ELC students still did not grasp the ability to think abstractly even after their third semester. Also, it should be noted that few students remained on profile during their third semester and the sample size was significantly lower than the first semester in the Science Program. Furthermore, the students who were not given any additional support through remediation in their first semester experienced the most difficulty; none of these weak students remained on profile. This evidence supports the argument for remediation in the first semester for those students who need it.

The third course in Physics requires that students use comprehension to understand abstract notions (Dickie, 2003). In this course, it is unlikely that a student who uses surface learning strategies and does not have an understanding of the abstract concepts will be able to succeed.

5.3.5 Performance in Biology NYA

General Biology I (Biology NYA) is an introductory college-level course compulsory for all Science students and is a prerequisite for all other Biology courses offered by the College. The main focus of this course is to recognize and characterize life forms with respect to their structure, body systems, mutual interactions, and their interactions with the environment. To achieve the goals of the course, the student is required to develop a good understanding of the formative elements, both physical and biological, affecting life. Students normally take Biology NYA in their third semester.

The analysis of all the average grades and pass rate in Biology NYA compared to other courses in the Science Program showed that both were significantly higher than any other of the Science courses with very few students who do not succeed. The weak students who did not have any remediation performed the poorest of all the groups. Again, these students were given no support when they entered the college. Additionally, this particular group of students had a large variance of grades. This further supports the assumption that if the college is going to accept weaker students it should give them support that they need to be successful. The comparison of the remedial ELC groups demonstrated that the Chemistry ELC group was the weakest also having the greatest variance of grades within the group. At least 25% of these students failed Biology NYA. They performed as poorly as those weak students who did not have any remediation at all. The weakness in Chemistry is again resonated in Biology. Examination of the mark distribution as a function of the group indicated that the students who had a weakness in Physics only (Physics ELC) performed almost equally as well as students in the regular students. This may be due to the supposition that Biology is highly descriptive and content-laden which requires an inductive thinking process similar to that required in Chemistry. Therefore, a student who performs well in Chemistry will most likely perform well in Biology. In Biology, the student is required to extrapolate their knowledge from the specific to the general (Becher 1989; Donald 2002). Students, who possess a strong Chemistry background, can presumably transfer and use this inductive thinking skill to Biology. Furthermore, Physics remediation helped these students attain logical structure required for problem solving which was the focus in the laboratory that contributed significantly to the final grade.

5.4 Retention of Students

The study of the trajectory that Science students follow as they advanced through the Science Program revealed that a large proportion of regular students, 84.7%, stayed on profile after the first semester. The Chemistry ELC and weaker non-remedial regular students' profiles were similar; however, only about half of them remained on target after their second course in Chemistry, Chemistry NYB. These two groups appeared to have the most difficulty succeeding in Chemistry NYB. It was not surprising to observe that only about a third of the entire remedial group students remained on profile in their third semester to take Physics NYB compared to 65.5% of the regular students who remained on profile. Interestingly, none of the weaker non-remedial regular students remained on profile by the third semester and were able to take Physics NYB. This implies that they did not pass their previous Physics courses.

The retention profiles for Biology NYA were somewhat more positive than for Physics NYB. Approximately half of the students in Chemistry ELC and those who took Physics ELC were on profile to take Biology NYA. However, as expected, this percentage was substantially lower when compared to the regular students where 77.3% were on profile. Surprisingly, the students that were in both Chemistry ELC and Physics ELC did slightly better than the other remedial groups and approximately 60% of them were able to take Biology NYA. Only a third of the remaining weaker non-remedial students were on profile to take Biology NYA.

Although the remedial students took longer to succeed, they were ultimately successful and benefited from a Science education that they otherwise may not have had the opportunity to pursue had the usual admission requirements been strictly followed. It is the opinion of this author that it is more important to consider the retention of these students in the program and college rather than measure success in terms of whether or not they graduated after four semesters.

The retention of the students was determined as a function of the program they were enrolled in at the expected time of graduation. It was assumed that if a student remained in the Science Program after four semesters, they would eventually graduate since the likelihood of them dropping out or switching programs is doubtful since they had invested a considerable amount of effort. The students who took both ELC in Chemistry and in Physics had greatest retention in Science. These results paralleled the regular students, 76%. It was found that when most of the regular students and the students who took both Chemistry ELC and Physics ELC left the Science Program, they switched to the Commerce program. Less than 10% of these students abandoned the college.

A little less than half of the students who took Chemistry ELC persisted in the Science Program. They were found to be the weakest of all remedial students. However, most of these students switched to other programs and similarly to the regular students, less than 10% dropped out of college or transferred to another college.

There is a strong connection to how well students perform within the program and retention. Almost two thirds of those students who took Physics ELC remained in Science. These students also had better average grades than the Chemistry ELC students. The remainder of these students switched to other programs, predominantly Commerce; 10% abandoned the college.

The weaker non-remedial students had the greatest dropout rate among all Science students. Their retention in Science paralleled the Chemistry ELC students. Perhaps if additional support was given to them in their first semester, the retention rate could have been better.

Interestingly, the findings of this research are consistent with the findings of Shaw (1997) who found that students who were enrolled in remedial courses performed more poorly than those who did not. However, there is some inconsistency in the claim that students take longer to complete their university degrees. The students who had remediation in both Chemistry and Physics in the cohorts studied had similar profiles in terms of being on target for graduation when compared to the regular students. This may be due to the sample size that may bias these results.

5.5 Discussion and Conclusions

The prevalence of students who are under prepared is widespread and the fastest growing college and university programs in the United States are geared to developmental education (Moore & Carpenter, 1987). Student retention is the result of improved programs and services within institutions and improvement in student learning. Students are likely to persist if they perceive they are learning (Noel, 1987). The ELC students can be considered as "persistors." The data revealed that a student who was weak in Physics but strong in Chemistry was more persistent in the Program and achieved better overall academic performance. Those who had ability in Chemistry, had the necessary skills required to learn Science and therefore may have been more motivated to stick to the program. It is likely that they persevered in the Science Program because they were learning even though it was more challenging for them compared to the regular students. Moreover, when they decided to switch programs, most of them opted for the Commerce Program. In this program, they could utilize the mathematical and analytical abilities that they presumably acquired in the Science Program.

Special considerations should be made for students who are weak in Chemistry such as a adapting remedial Chemistry courses that foster abstract thinking skills. Perhaps the college should consider offering a second Chemistry course such as Chemistry NYB with extra time. It appears that the skills that they should have acquired in their introductory Chemistry courses both at High School and at the CEGEP level are necessary for their success in other Science courses.

The results of the current study demonstrate that accepting under prepared students who would not normally be accepted into the Science Program and that by providing them with support through remediation in Chemistry and Physics is beneficial. The offering of "Extended Lecture Classes" is an effective way to help less prepared students adapt to the rigor of college Science. Although the ELC students did not perform as well as regular students in their subsequent courses, their persistence, as demonstrated by the retention rates is a good indicator that these students are on the path to formal operations. These students have been given an opportunity to embrace scientific knowledge that perhaps without the offering of Extended Lecture Class courses could not have been possible.

This study provides information to college administrators and government officials who decide on admission standards and the availability of resources that remediation through extra class time is desirable and beneficial to less prepared students. It also provides an insight of the impact on performance in Science courses when there is a weakness in a specific discipline such as Chemistry. It helps educators understand why certain less prepared Science students are struggling. With this information, educators can thoughtfully adjust pedagogy so that concepts could be learned more efficiently and can try to find ways to increase meaningful learning.

5.6 Limitations of the Study

A limitation of the study is that the attitudinal, motivational and learner characteristics of these weak students were not investigated. This would have given a further insight into how to tailor future offerings of remedial courses. The specific outcomes that targeted the performance of the different remedial groups may vary from cohort to cohort due to differences in the characteristics of the teachers and student groups. However, the general trends observed can be delineated to other cohorts since this was a longitudinal study spanning over 6 years.

Another limitation of this study was the follow-up of these students at the university level. It would be interesting to determine if the "persistors" continued their studies in Science and how well they were performing. The qualitative data findings were limited to a suggested casual relationship between the characteristics of the students and their academic achievements. The factors that cause slower learning speed were not empirically established in the scope of this study.

5.7 Commentary

Informal discussions with the teachers of the remedial groups (personal contacts) suggested that remediation is worthwhile for those students who are motivated to learn provided that the course is offered by a devoted, enthusiastic and knowledgeable professor. ELC gives students who would not normally be accepted into the Science Program an opportunity to develop their scientific skills and perhaps even pursue a career in the Sciences. One professor commented that not only does remediation help the students be successful in their course work but also in developing study skills that perhaps they are lacking in the first place. Most teachers commented that these students lack organization skills and an initial lack of motivation seemed to be a contributing factor which explains why these students were in the remedial class in the first place. During the course of the semester teachers observed positive changes in both the aptitudes and attitude of their class. This extra help seemed to help the students get beyond that first hurdle of college studies. From the point of view of this researcher, remediation through Extended Lecture Class is worthwhile and should be continued. However, given that weak Chemistry students seem to experience the most difficulty in Science, instructional strategies that foster abstract thinking should be intentionally implemented into the curriculum.

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APPENDIX 1

MARKING SCHEMES OF CHEMISTRY NYA

APPENDIX 1

MARKING SCHEMES OF CHEMISTRY NYA

Fall 2001 Multi-sectional Course Assessment Coherence Grid
Chemistry 202-NYA-05

Teacher	Labs	Lab	Int. Act.	Assignments	Quizzes	Tests		Final Exam
	%	%	%	%	%	Number	%	%
Options				A or B or C	A or B or C		A or B or C	A or B or C
A		15	5			2	50	30
B	15	15	5		6 10 8	2	24 or 40 or 12	50 or 30 or 60
C	15	15	5			3	50 or 30	30 or 50
D	15	15	5		6 10 8	2	24 or 40 or 12	50 or 30 or 60
E	15	15	5		10	2	20 or 40	50 or 30
F	15	15	5			2	50 or 30	30 or 50

Fall 2002 Multi-sectional Course Assessment Coherence Grid
Chemistry 202-NYA-05

Teacher	Labs	Lab	Int. Act.	Assignments		Quizzes	Tests		Final Exam
	%	%	%	Number	%	%	Number	%	%
Options					A or B or C	A or B or C		A or B or C	A or B or C
G	15	15	5		20 or 10		3	30	30 or 40
B	15	15	5			6 10 8	2	24 or 40 or 12	50 or 30 or 60
H	15	15	5			Incl. in tests	3	50 or 30	30 or 50
C	15	15	5				3	50 or 30	30 or 50
E	15	15	5			10	2	20 or 40	50 or 30
F	15	15	5			Incl. in tests	3	40	40

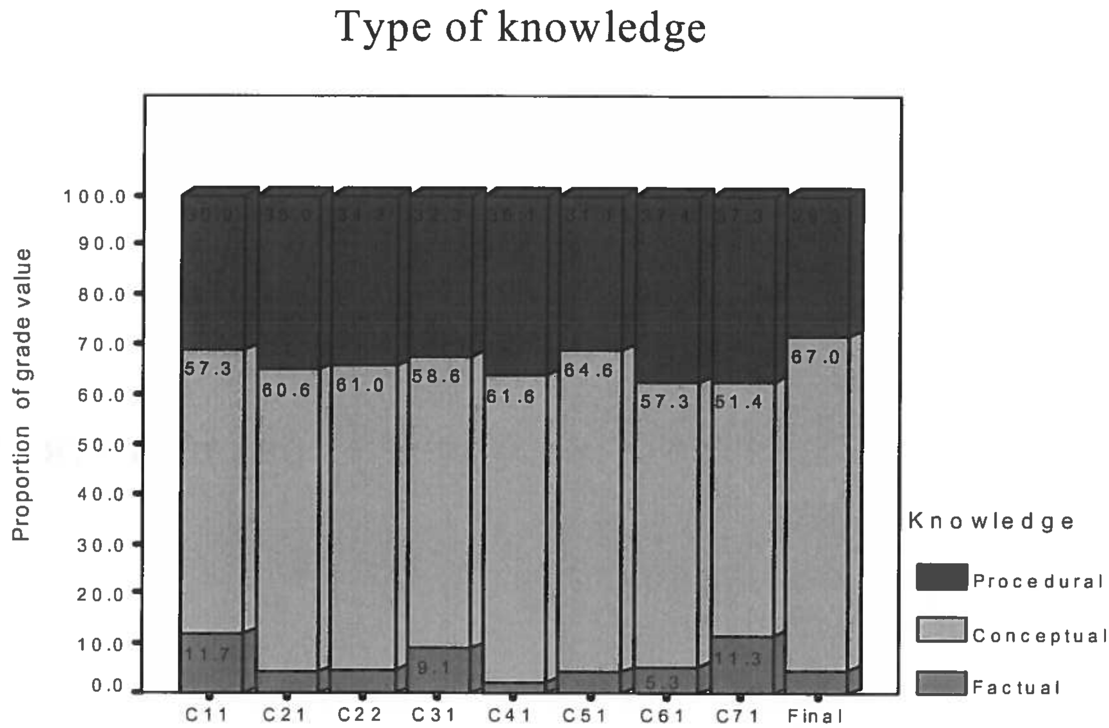
<u>Fall 2003 Multi-sectional Course Assessment Coherence Grid</u>
<u>Chemistry 202-NYA-05</u>

Teacher	Labs	Lab	Int. Act.	Assignments	Quizzes	Tests	Final Exam
	%	%	%	r %	%	Number %	%
Options					**A or B or C**	**A or B or C**	**A or B or C**
J	15	15	5	5		? 35	40
G	15	15	5		6 10 8	2 24 or 40 or 12	50 or 30 or 60
B	15	15	5		5	3 45 or 25	30 or 50
H	15	15	5			3 50 or 30	30 or 50
C	15	15	5		10	2 20 or 40	50 or 30
E	15	15	5		10	4 35	35
F	15	15	5		10	4 35	35
I		15	5		5	3 45 or 25	30 or 50

APPENDIX 2

TYPES OF KNOWLEDGE FOR CHEMISTRY NYA

APPENDIX 2



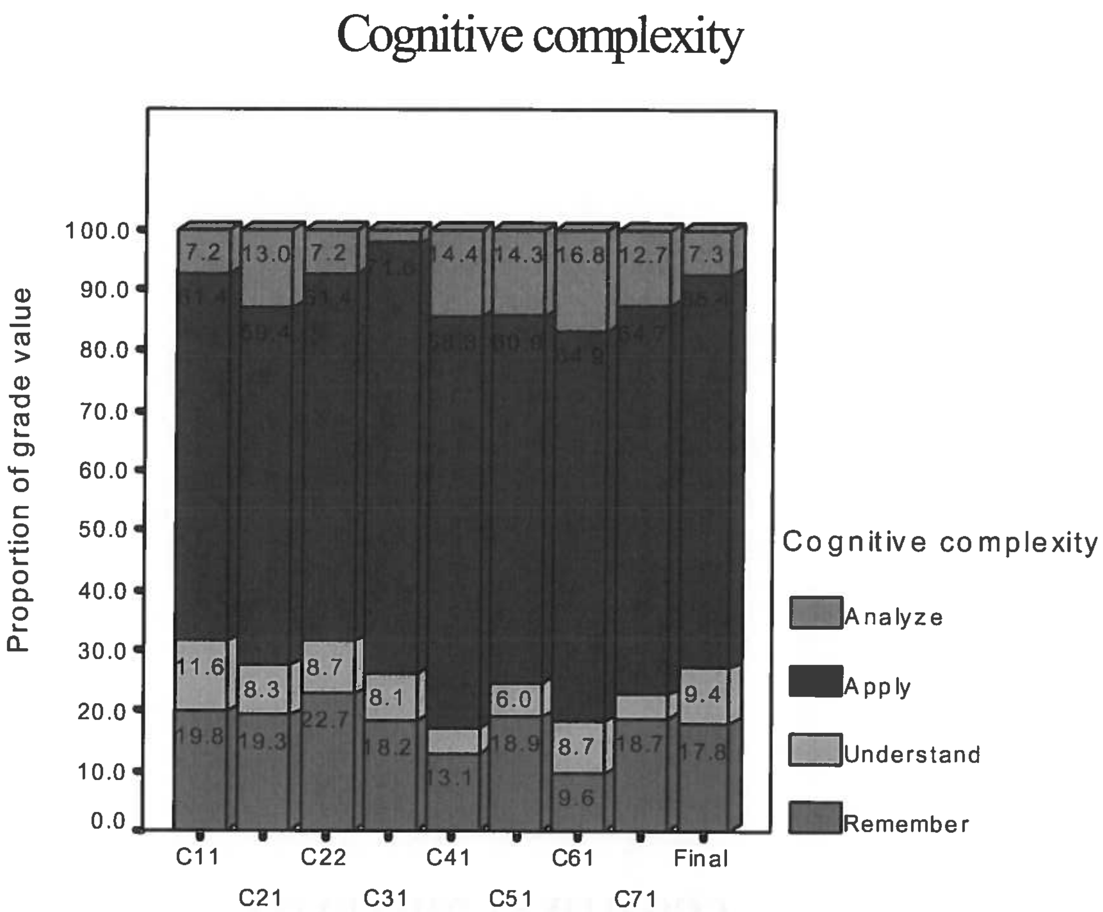
Graph 1.The Types of Knowledge Required for Chemistry NYA

This stacked bar chart represents the percentage of the final grade that was attributed to the type of knowledge required in the assessment tasks. The codes on the x-axis refer to different sections of the same course. Section C21 was the Extended Lecture Class.

APPENDIX 3

COGNITIVE COMPLEXITY

APPENDIX 3



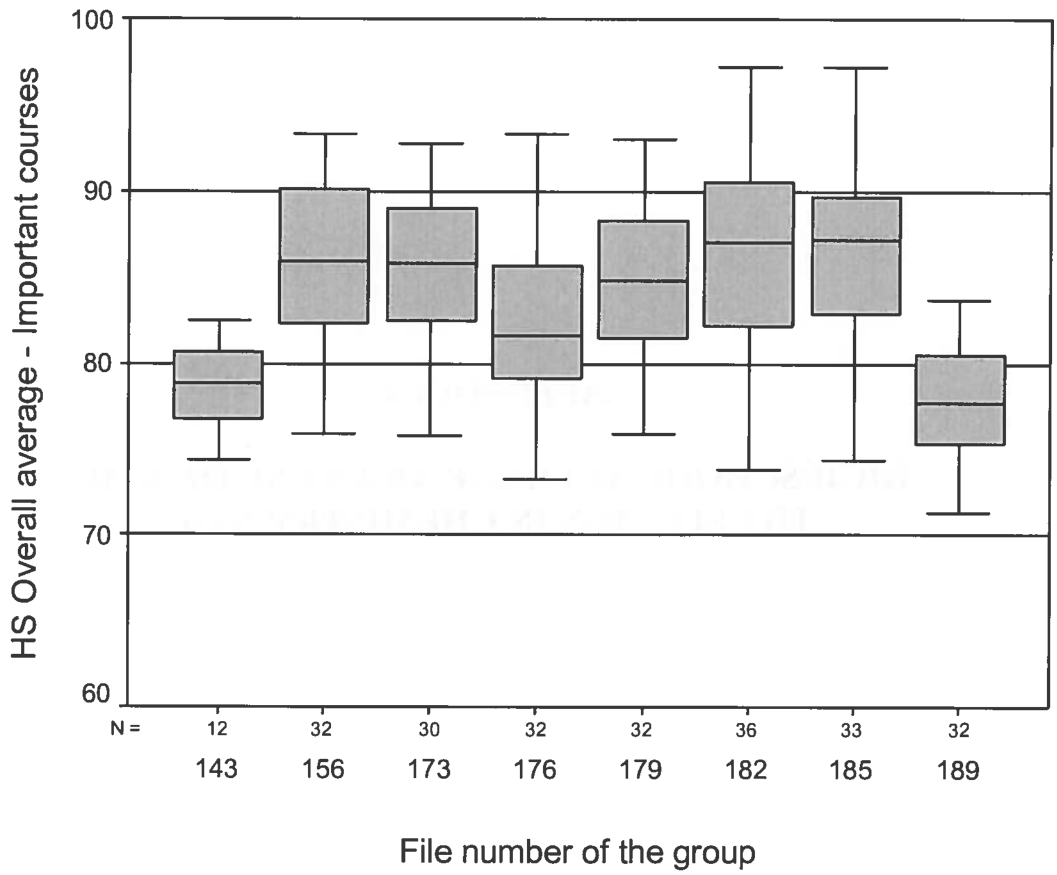
Graph 2. The Cognitive Complexity of Chemistry NYA
This stacked bar chart represents the percentage of final grade that was attributed to the cognitive complexity of the assessment task. The codes on the x-axis refer to different sections of the same course. Section C21 was the Extended Lecture Class.

APPENDIX 4

HIGH SCHOOL AVERAGE AS A FUNCTION OF THE SECTION IN CHEMISTRY NYA

APPENDIX 4

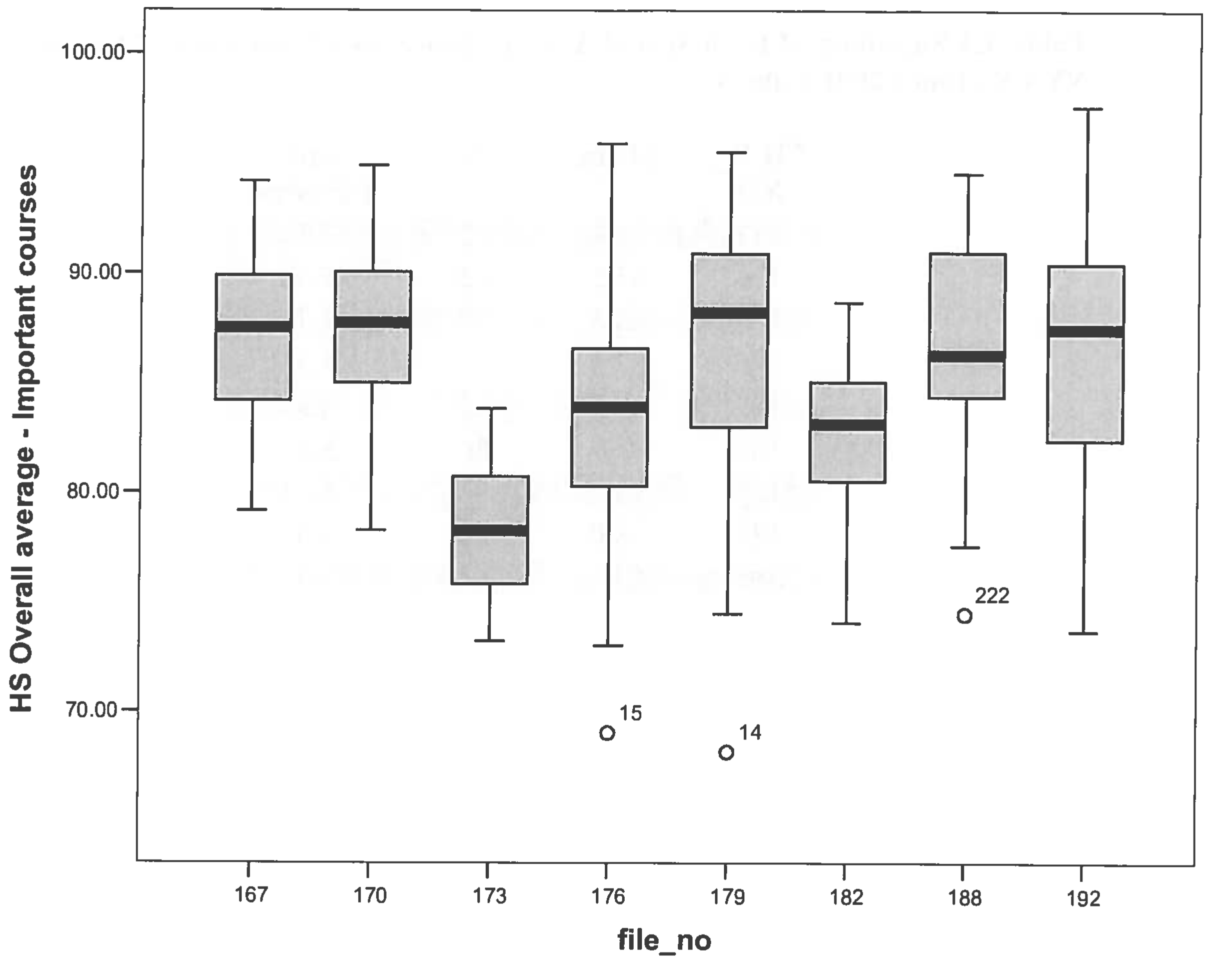
HIGH SCHOOL AVERAGES AS A FUNCTION OF THE SECTION IN CHEMISTRY NYA



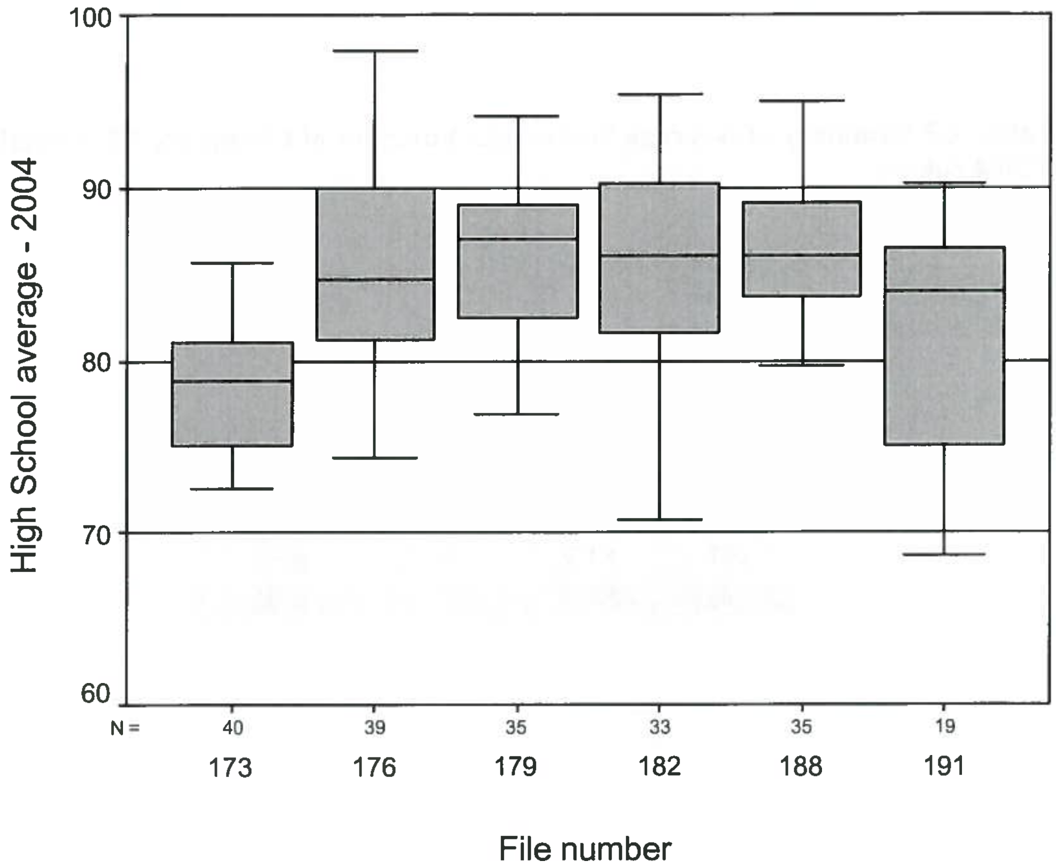
Box Plot A.1 High School averages of the 2001 Cohort represents the range of the High School grade as a function of the sections of Introductory Chemistry Part 1 for the 2001 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. The ELC group has file number 173. All remaining file numbers are the regular students. Note section 143 was a very small section that had many students that did not have an 80% overall average.

Table A.1 Summary of High School Average Scores as a Function of Chemistry NYA Section F2001 Cohort

FILE_NO	Mean	N	Std. Deviation
143	78.6	12	2.38
156	85.5	32	5.00
173	85.4	30	4.70
176	82.5	32	4.82
179	84.6	32	4.33
182	85.9	36	5.35
185	86.2	33	5.04
189	78.0	32	3.07
Total	83.8	239	5.38



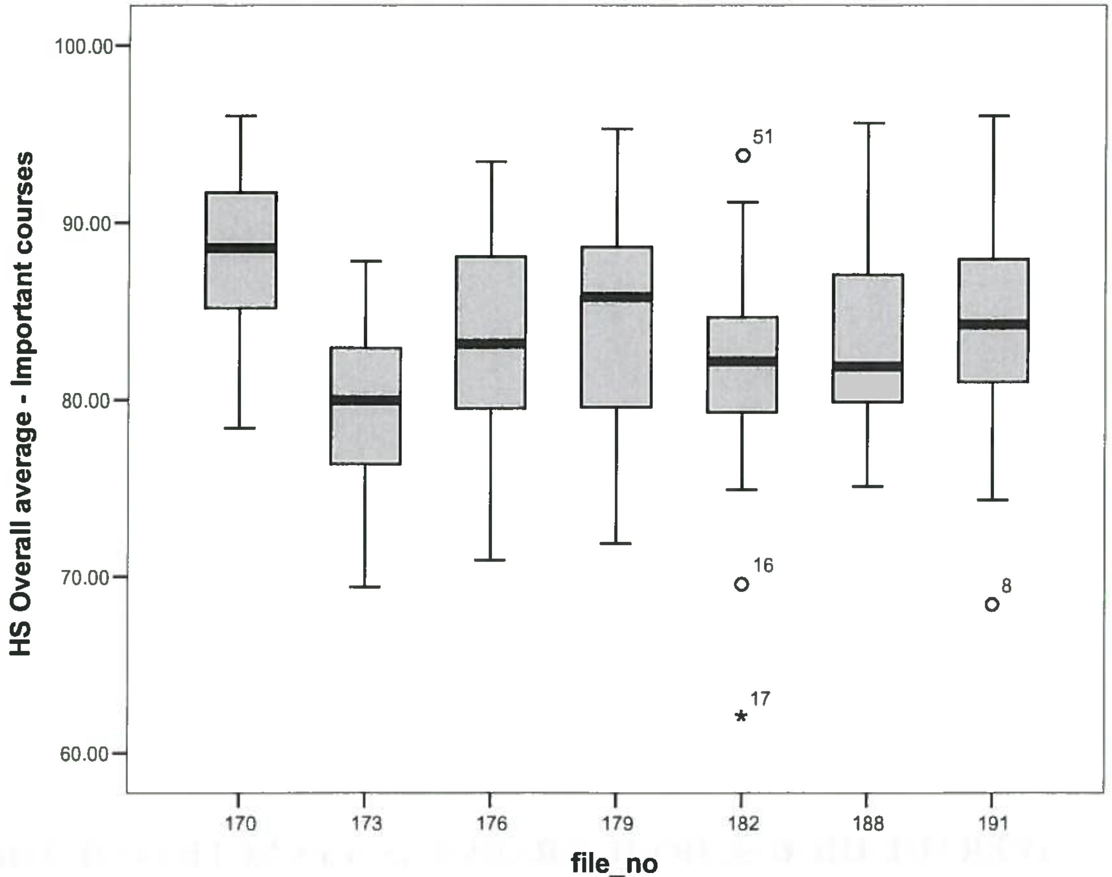
Box Plot A.2 High School Averages of the 2003 Cohort represents the range of the High School grade as a function of the sections of Introductory Chemistry Part 1 (Chemistry NYA) for the 2002 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. The ELC group has file number 173. All remaining file numbers are the regular students.



Box Plot A.3 High School averages of the 2004 Cohort represents the range of the High School grade as a function of the sections of Introductory Chemistry Part 1 for the 2004 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. The ELC group has file number 173. All remaining file numbers are the regular students. Note section 191 has some students who do not have an 80% overall average.

Table A.3 Summary of Average Scores as a Function of Chemistry NYA Section F2004 cohort

FILE_NO	Mean	N	Std. Deviation
173	78.5	40	3.58
176	85.5	39	6.10
179	86.1	35	4.38
182	85.4	33	6.07
188	86.4	35	4.07
191	81.2	19	6.59
Total	84.0	201	5.90



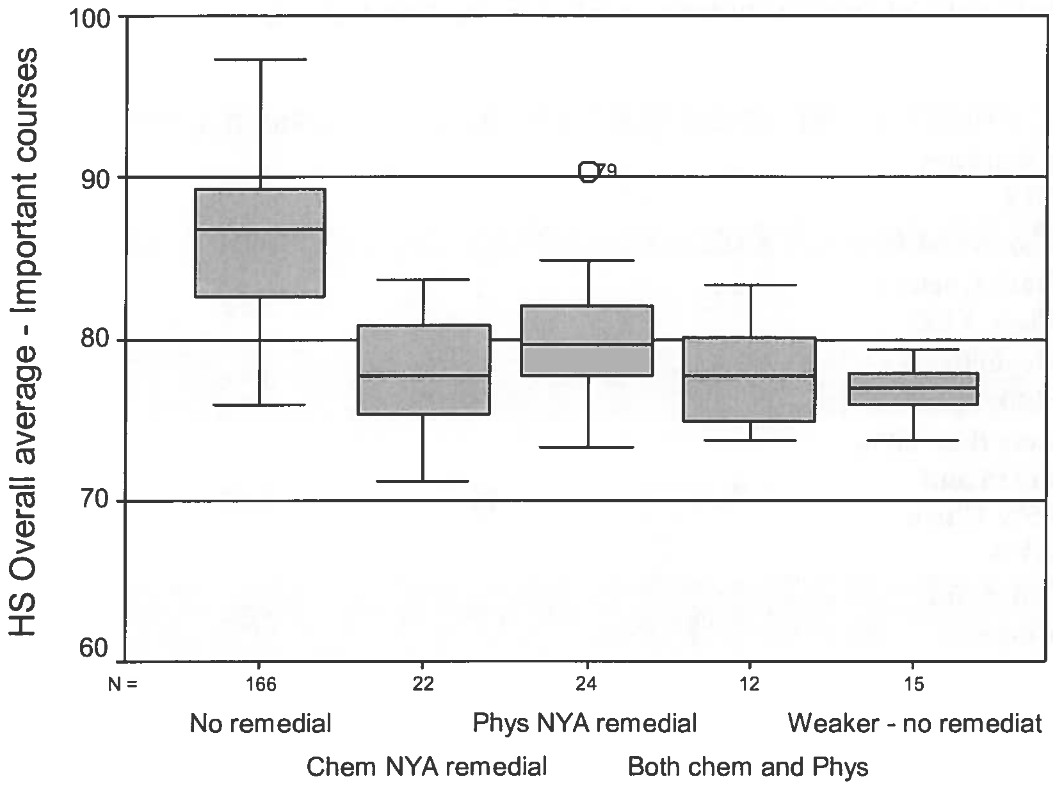
Box Plot A.4. High School averages of the 2005 Cohort represents the range of the High School grade as a function of the sections of Introductory Chemistry Part 1 for the 2005 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. The ELC group has file number 173. All remaining file numbers are the regular students.

APPENDIX 5

AVERAGE HIGH SCHOOL GRADES AS A FUNCTION OF THE ELC GROUP

APPENDIX 5

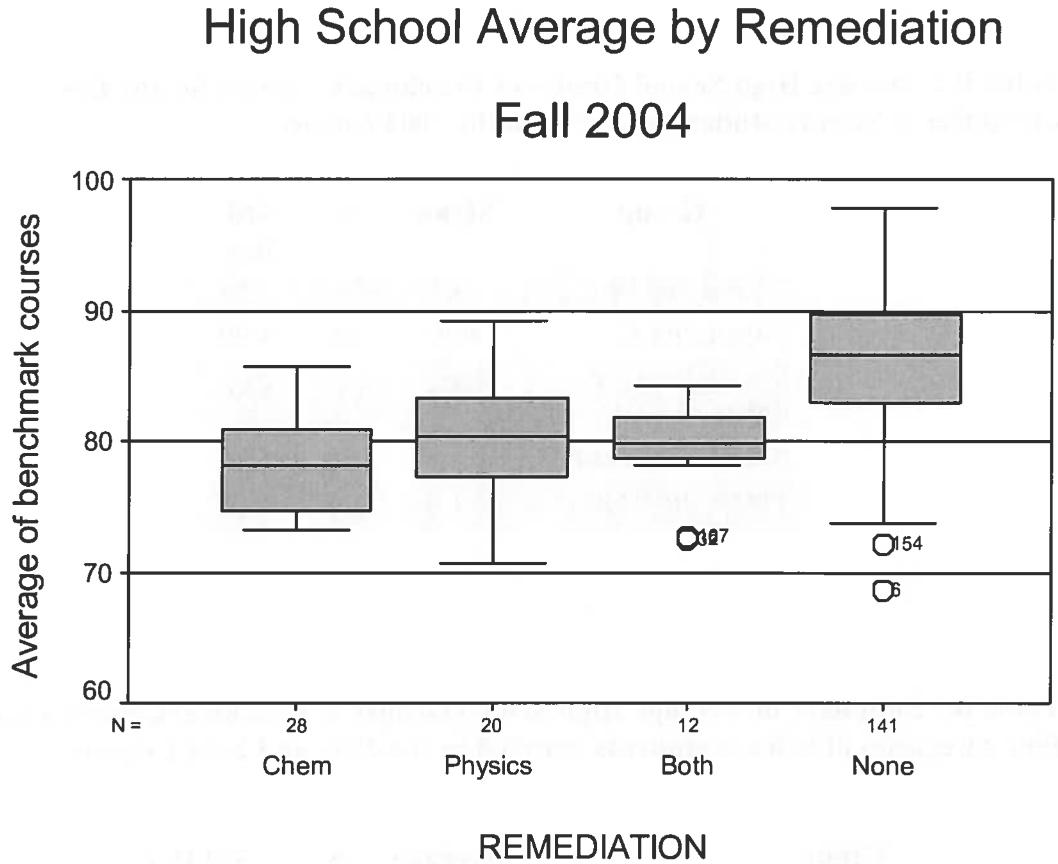
AVERAGE HIGH SCHOOL GRADES AS A FUNCTION OF ELC GROUP



Box Plot B.1 High School Grades Fall 2001 Cohort represents the range of the High School grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table B.1 Average High School Grades of Benchmark courses for the five categories of Science students enrolled in the 2001 Cohort.

Group	Mean	N	Std. Dev.
Chemistry ELC	77.8	22	3.09
Physics ELC	80.2	24	3.48
Both Chem. & Phys. ELC	77.8	12	3.12
Regular students	86.1	166	4.35
Less than 80% in HS and 65% Chem NYA	76.9	15	1.67
Totals for Cohort	83.8	239	5.38



Box Plot B.2 High School Grades Fall 2004 Cohort represents the range of the High School grades for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table B.2 Average High School Grades of Benchmark courses for the five categories of Science students enrolled in the 2004 Cohort.

Group	Mean	N	Std. Dev.
Chemistry ELC	78.1	28	3.58
Physics ELC	80.0	20	4.90
Both Chem. & Phys. ELC	79.4	12	3.59
Regular students	86.0	141	5.26
Totals for Cohort	84.0	201	5.90

Table B.3 Summary of Average High School Grades of Benchmark courses for the four categories of Science students enrolled in the 2001 and 2004 Cohorts

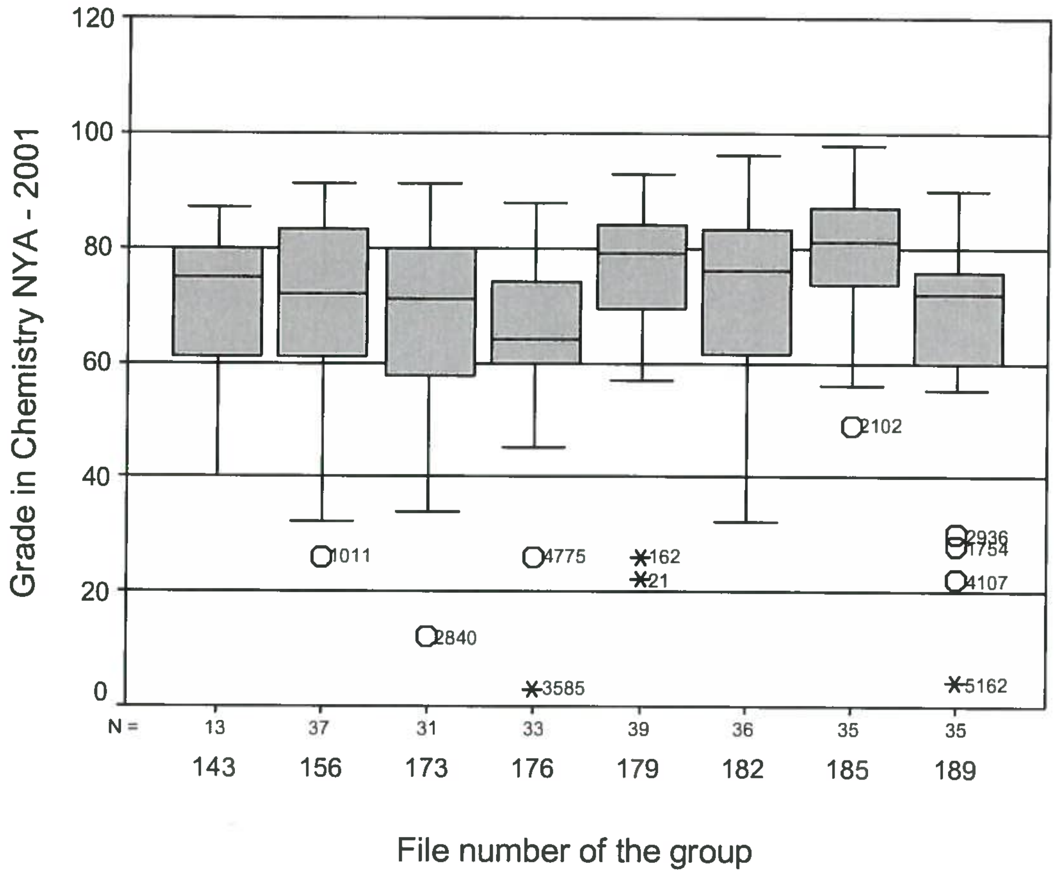
Group	Average Mean	N	Std.Dev. Range
Chemistry ELC	77.9	50	3.09-3.58
Physics ELC	80.1	44	3.48-4.90
Both Chem. & Phys. ELC	78.6	24	3.12-3.59
Regular students	86.1	307	5.26-5.52
Less than 80% in HS	76.9	15	1.67
Totals for all Cohorts	84.2	493	5.38-5.90

APPENDIX 6

THE PERFORMANCE IN CHEMISTRY NYA

APPENDIX 6

THE PERFORMANCE IN CHEMISTRY NYA



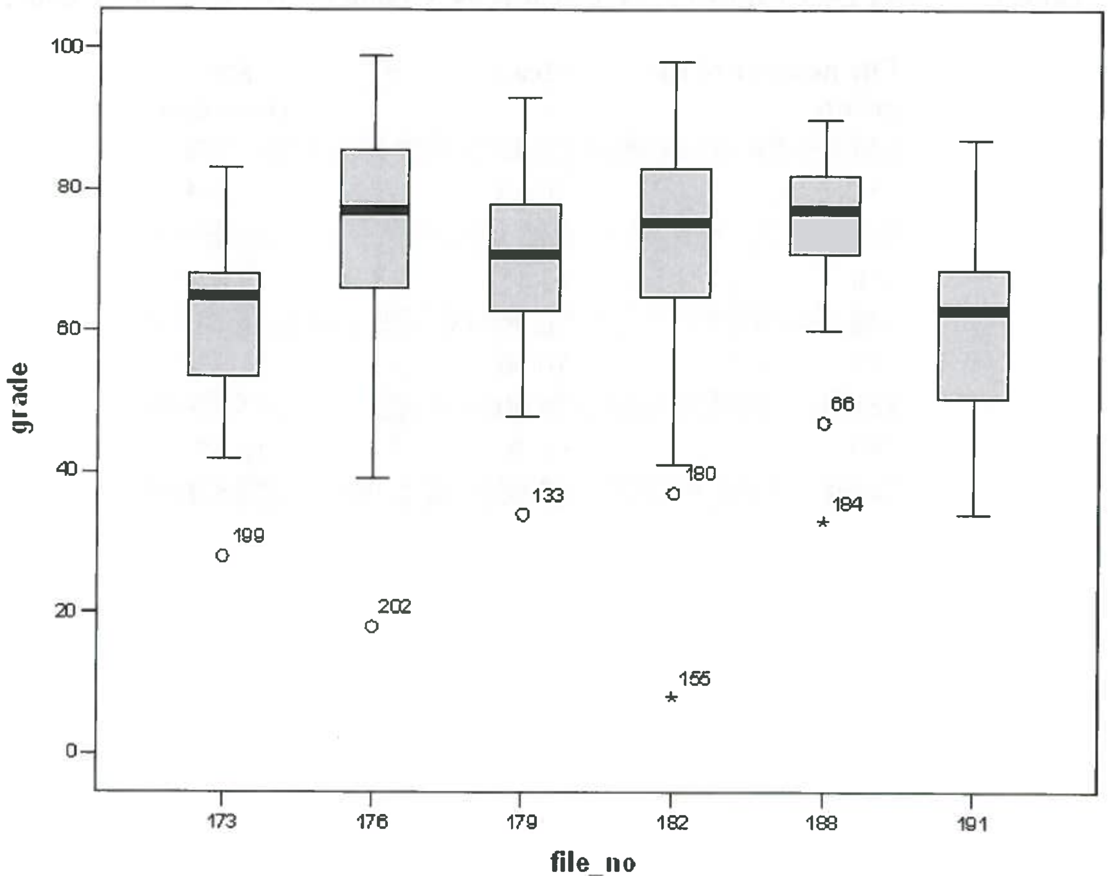
Box Plot C.1 Fall 2001 Chemistry NYA Grades by Section

This box plot represents the range of all sections of Introductory Chemistry Part 1 (Chemistry NYA) for the 2001 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. File number 189 is the ELC section. All remaining file numbers are the regular students. Note file 143 had some students that did not have an 80% overall High School average.

Table C.1 Average Chemistry NYA Scores by Section for the Fall 2001 Cohort

File number of the group	Mean	N	Std. Deviation
143	68.92	13	15.075
156	70.62	37	15.828
173	66.77	31	17.260
176	63.15	33	17.070
179	74.56	39	15.191
182	70.56	36	16.338
185	79.40	35	11.379
189	65.46	35	18.674
Total	70.20	259	16.578

CHEMISTRY NYA FALL 04 - IB excluded



Box Plot C.2 Chemistry NYA averages 2004 Cohort by Section represents the range of all sections of Introductory Chemistry Part 1 for the 2004 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. File number 173 is the ELC section. All remaining file numbers are the regular students. Note file 191 had some students that did not have an 80% overall High School average.

Table C.2 Average Chemistry NYA Scores by Section for the Fall 2004 Cohort

File number	Mean	N	Std. Deviation
173	60.73	40	11.964
176	74.08	39	15.918
179	70.66	38	11.840
182	71.91	34	17.705
188	73.38	37	13.508
191	61.85	20	13.758
Total	69.23	208	15.031

Table C.3 Summary of the Average Chemistry NYA Scores by Section for the Fall 2001 and Fall 2004 Cohorts

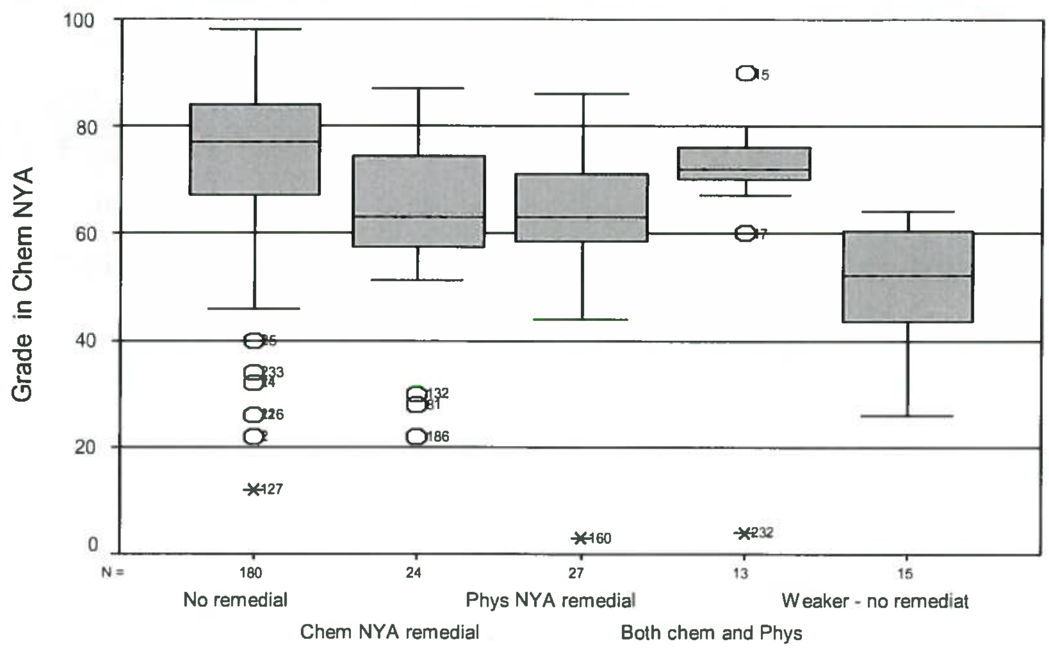
Group	Mean	N	Std. Deviation Range
ELC	63.1	75	12.0 -18.7
Regular Students	70.5	396	11.4-17.7
Total	69.7	471	11.4-18.7

APPENDIX 7

THE PERFORMANCE IN CHEMISTRY NYA BY GROUP

APPENDIX 7

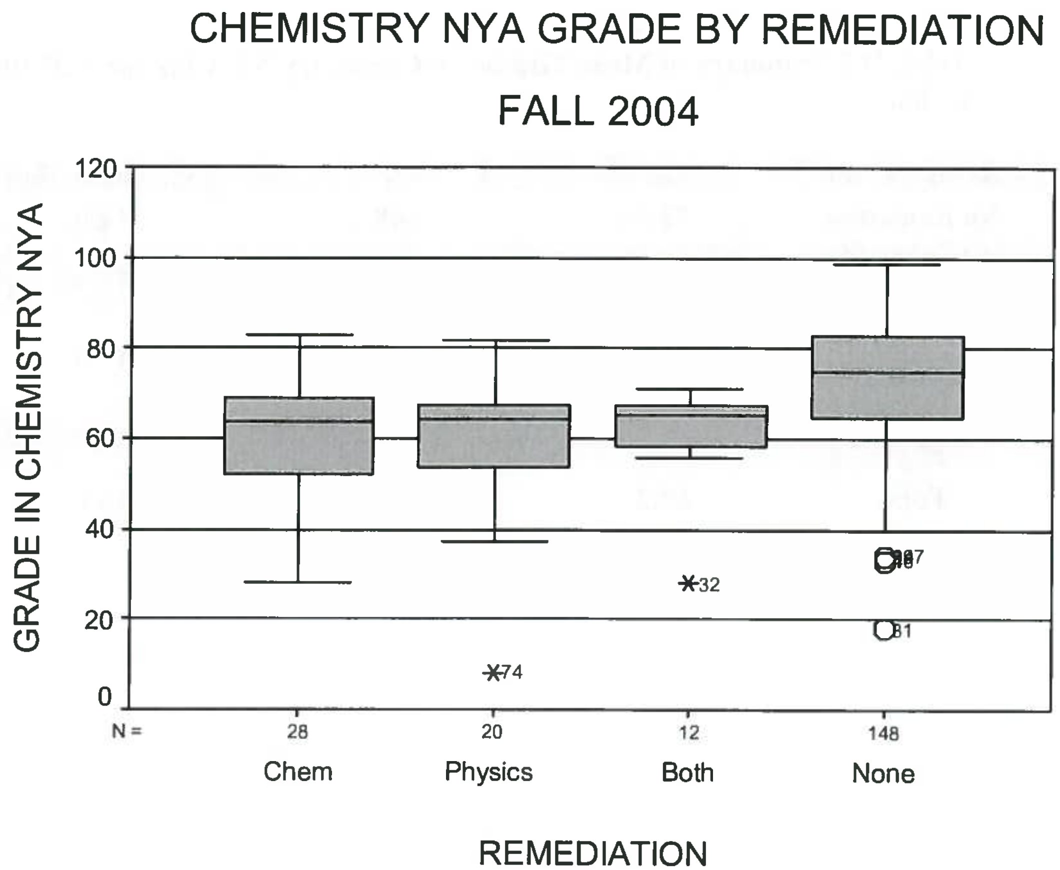
THE PERFORMANCE IN CHEMISTRY NYA BY GROUP



Box Plot D.1 Grades Chemistry NYA Fall 2001 represents the range of the Chemistry NYA grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table D.1 Summary of Mean Grades in Chemistry NYA for the Fall 2001 Cohort

Remediation	Mean	N	Std. Deviation
No Remedial	72.3	195	15.8
Chem NYA remedial	63.1	24	17.1
Phys NYA remedial	62.1	27	16.0
Both Chem and Phys	68.5	13	20.6
Weaker no Remediation	51.27	15	11.0
Total	70.2	259	16.6



Box Plot D.2 Grades Chemistry NYA Fall 2004 represents the range of the Chemistry NYA grades for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table D.2 Summary of Mean Grades in Chemistry NYA for the Fall 2004 Cohort

Remediation	Mean	N	Std. Deviation
No Remedial	72.9	148	14.0
Chem NYA remedial	60.5	28	12.4
Phys NYA remedial	59.2	20	17.0
Both Chem and Phys	61.2	12	11.4
Total	69.2	208	15.0

APPENDIX 8

PASS RATES IN CHEMISTRY NYA BY GROUP

APPENDIX 8

PASS RATES IN CHEMISTRY NYA BY GROUP

Table E.1 Statistical Descriptive for the Fall 2001 Cohort

	Remediation			Statistic	Std. Error
AGrade Numeric	No remedial	Mean		72.31	1.133
		95% Confidence Interval for Mean	Lower Bound	70.08	
			Upper Bound	74.55	
		5% Trimmed Mean		73.52	
		Median		76.00	
		Variance		250.175	
		Std. Deviation		15.817	
		Minimum		12	
		Maximum		98	
		Range		86	
		Interquartile Range		20.00	
		Skewness		-1.199	.174
		Kurtosis		1.522	.346
	Chem NYA remedial	Mean		63.08	3.488
		95% Confidence Interval for Mean	Lower Bound	55.87	
			Upper Bound	70.30	
		5% Trimmed Mean		64.02	
		Median		63.00	
		Variance		291.906	
		Std. Deviation		17.085	
		Minimum		22	
		Maximum		87	
		Range		65	
		Interquartile Range		17.50	
		Skewness		-1.039	.472
		Kurtosis		.800	.918
	Phys NYA remedial	Mean		62.07	3.075
		95% Confidence Interval for Mean	Lower Bound	55.75	
			Upper Bound	68.40	
		5% Trimmed Mean		63.49	
		Median		63.00	
		Variance		255.379	
		Std. Deviation		15.981	

		Minimum		3	
		Maximum		86	
		Range		83	
		Interquartile Range		15.00	
		Skewness		-1.839	.448
		Kurtosis		6.432	.872
	Both chem and Phys	Mean		68.46	5.724
		95% Confidence Interval for Mean	Lower Bound	55.99	
			Upper Bound	80.93	
		5% Trimmed Mean		70.85	
		Median		72.00	
		Variance		425.936	
		Std. Deviation		20.638	
		Minimum		4	
		Maximum		90	
		Range		86	
		Interquartile Range		9.50	
		Skewness		-2.852	.616
		Kurtosis		9.394	1.191

STEM-AND-LEAF PLOTS FOR CHEMISTRY NYA FALL 2001

Grade Numeric Stem-and-Leaf Plot for
COURSE2= **No remedial**

```
 Frequency    Stem &  Leaf

     7.00 Extremes    (=<32)
     1.00        3 .  4
     1.00        3 .  9
     4.00        4 .  0034
     4.00        4 .  6699
     8.00        5 .  00022444
     5.00        5 .  56778
    23.00        6 .  00000001111111133333344
    13.00        6 .  5567777789999
    23.00        7 .  00111122222222233344444
    24.00        7 .  555555666667777778889999
    40.00        8 .  0000000000000111222222233333333333444444
    27.00        8 .  555555666666666777777888889
    11.00        9 .  00011123344
     4.00        9 .  5668
 Stem width:      10
 Each leaf:       1 case(s)
```

Grade Numeric Stem-and-Leaf Plot for
COURSE2= **Chem NYA remedial**

```
 Frequency    Stem &  Leaf

     3.00 Extremes    (=<30)
     1.00        5 .  1
     3.00        5 .  578
     6.00        6 .  000224
     1.00        6 .  8
     4.00        7 .  2334
     2.00        7 .  58
     3.00        8 .  113
     1.00        8 .  7

 Stem width:      10
 Each leaf:       1 case(s)
```

Grade Numeric Stem-and-Leaf Plot for
COURSE2= **Phys NYA remedial**

```
 Frequency    Stem &  Leaf
```

```
  1.00 Extremes    (=<3)
  1.00        4 .  4
  1.00        4 .  5
  3.00        5 .  023
  1.00        5 .  7
 10.00        6 .  0011133344
  2.00        6 .  58
  4.00        7 .  0234
   .00        7 .
  3.00        8 .  022
  1.00        8 .  6

Stem width:      10
Each leaf:        1 case(s)
```

Grade Numeric Stem-and-Leaf Plot for
COURSE2= **Both chem and Phys**

```
Frequency    Stem &  Leaf

  2.00 Extremes    (=<60)
  1.00        6 .  7
  6.00        7 .  012244
  1.00        7 .  6
  2.00        8 .  00
  1.00 Extremes    (>=90)

Stem width:      10
Each leaf:        1 case(s)
```

Table E.2 Pass Rates of Introductory Chemistry NYA by Group Fall 2001 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	7	7	2	30
% Failure Rate	25	25.9	15.4	15.4
Pass with grade 60%-69%	7	12	1	36
% Pass grade 60%-69%	60	44.4	7.7	18.5
Pass grade 70-100%	10	8	10	129
% Pass grade 70-100%	41.7	29.6	76.9	66.2
% Overall Pass Rate	70.9	74.1	84.6	84.6
Total Students	24	27	13	195

Table E.3 Statistical Descriptive for the Fall 2004 Cohort

	REMEDIATION			Statistic	Std. Error
GRADE	Chem	Mean		60.54	2.340
		95% Confidence Interval for Mean	Lower Bound	55.73	
			Upper Bound	65.34	
		5% Trimmed Mean		60.98	
		Median		63.50	
		Variance		153.295	
		Std. Deviation		12.381	
		Minimum		28	
		Maximum		83	
		Range		55	
		Interquartile Range		17.50	
		Skewness		-.598	.441
		Kurtosis		.339	.858
	Physics	Mean		59.20	3.806
		95% Confidence Interval for Mean	Lower Bound	51.23	
			Upper Bound	67.17	
		5% Trimmed Mean		60.78	
		Median		64.50	
		Variance		289.747	
		Std. Deviation		17.022	
		Minimum		8	
		Maximum		82	
		Range		74	
		Interquartile Range		14.50	
		Skewness		-1.580	.512
		Kurtosis		3.264	.992
	Both	Mean		61.17	3.303
		95% Confidence Interval for Mean	Lower Bound	53.90	
			Upper Bound	68.44	
		5% Trimmed Mean		62.46	
		Median		65.50	
		Variance		130.879	
		Std. Deviation		11.440	

	Minimum		28	
	Maximum		71	
	Range		43	
	Interquartile Range		10.50	
	Skewness		-2.527	.637
	Kurtosis		7.260	1.232
None	Mean		72.89	1.150
	95% Confidence Interval for Mean	Lower Bound	70.61	
		Upper Bound	75.16	
	5% Trimmed Mean		73.82	
	Median		75.00	
	Variance		195.885	
	Std. Deviation		13.996	
	Minimum		18	
	Maximum		99	
	Range		81	
	Interquartile Range		18.00	
	Skewness		-1.056	.199
	Kurtosis		1.703	.396

STEM-AND-LEAF PLOTS CHEMISTRY NYA FALL 2004

GRADE Stem-and-Leaf Plot for
REMED= **Chem**

Frequency	Stem &	Leaf
1.00	2 .	8
.00	3 .	
4.00	4 .	2359
5.00	5 .	12225
11.00	6 .	00025556678
6.00	7 .	012466
1.00	8 .	3

Stem width: 10
Each leaf: 1 case(s)

GRADE Stem-and-Leaf Plot for
REMED= **Physics**

Frequency	Stem &	Leaf
1.00 Extremes		(=<8)
2.00	3 .	79
1.00	4 .	1
2.00	5 .	34
11.00	6 .	22245577789
1.00	7 .	2
2.00	8 .	02

Stem width: 10
Each leaf: 1 case(s)

GRADE Stem-and-Leaf Plot for
REMED= **Both**

Frequency	Stem &	Leaf
1.00 Extremes		(=<28)
2.00	5 .	66
2.00	6 .	12
6.00	6 .	566788
1.00	7 .	1

Stem width: 10

Each leaf: 1 case(s)

GRADE Stem-and-Leaf Plot for
REMED= **None**

```
 Frequency    Stem &  Leaf

     5.00 Extremes    (=<34)
     1.00        4 .  0
     4.00        4 .  6789
     4.00        5 .  0114
      .00        5 .
    22.00        6 .  0000001111222222333334
    15.00        6 .  556666677778889
    22.00        7 .  0001122222222333344444
    21.00        7 .  555566677777888888899
    23.00        8 .  00000000111222233333444
    22.00        8 .  5566666777777888888999
     6.00        9 .  001133
     3.00        9 .  689

 Stem width:   10
 Each leaf:     1 case(s)
```

Table E.4 Pass Rates of Introductory Chemistry NYA by Group Fall 2004 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	10	6	3	14
% Failure Rate	35.7	30	25	9.5
Pass with grade 60%-69%	11	11	8	37
% Pass grade 60%-69%	39.3	55	66.7	25
Pass grade 70-100%	7	3	1	97
% Pass grade 70-100%	25	15	8.3	66.5
% Overall Pass Rate	64.3	70	75	90.5
Total Students	28	20	12	148

Summary Table E.5 Pass Rates of Introductory Chemistry NYA by Group for the Fall 2001 and 2004 Cohort

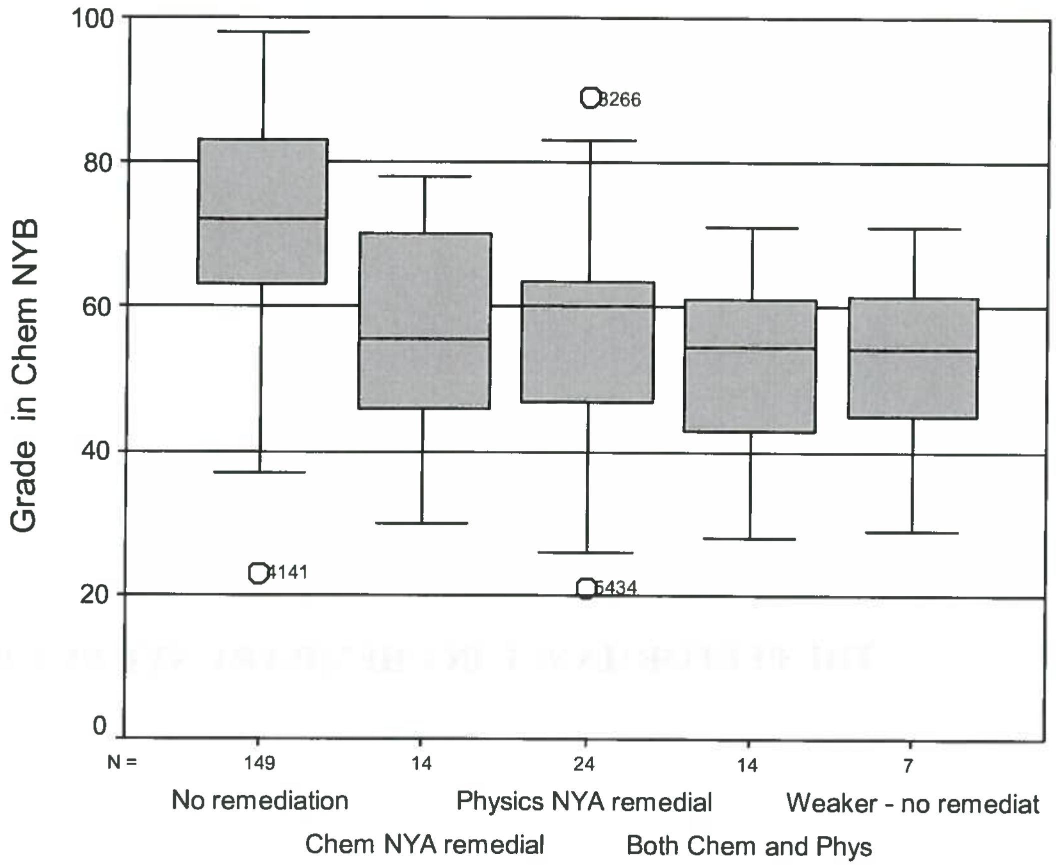
Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	17	13	5	44
% Failure Rate	30.45	28.0	20.2	12.5
Pass with grade 60%-69%	18	23	9	73
% Pass grade 60%-69%	49.7	49.7	37.2	21.8
Pass grade 70-100%	17	11	11	226
% Pass grade 70-100%	33.4	22.3	42.6	66.4
% Overall Pass Rate	67.6	72.1	79.8	87.6
Total Students	52	47	25	343

APPENDIX 9

THE PERFORMANCE IN CHEMISTRY NYB BY GROUP

APPENDIX 9

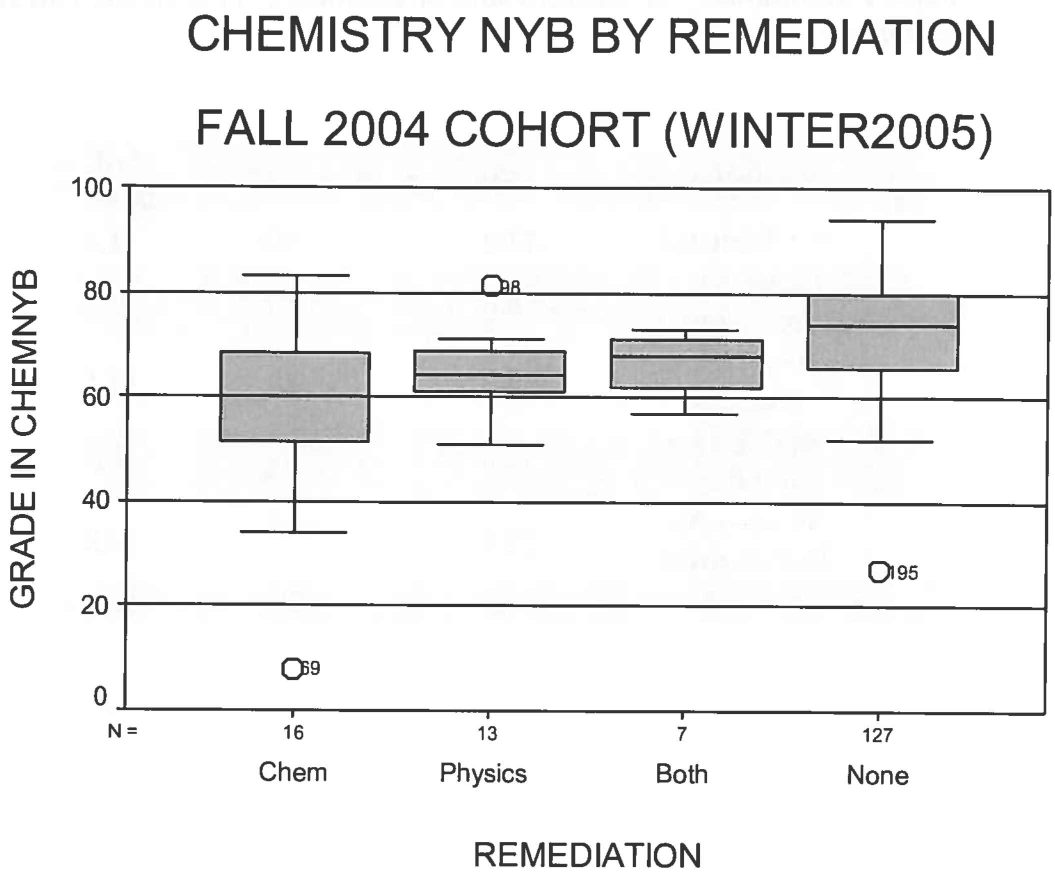
THE PERFORMANCE IN CHEMISTRY NYB BY GROUP



Box Plot F.1 Chemistry NYB Fall 2001 represents the range of the Chemistry NYB grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table F.1. Summary of Mean Grades in Chemistry NYB for the Fall 2001 Cohort

Remediation	Mean	N	Std. Dev
No Remedial	72.0	149	14.4
Chem NYA remedial	56.8	14	15.2
Phys NYA remedial	56.3	24	17.1
Both Chem and Phys	51.0	14	6.1
Weaker No Remediation	52.4	7	14.8
Total	67.1	208	16.6



Box Plot F.2 Chemistry NYB Fall 2004 represents the range of the Chemistry NYB grades for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included

Table F.2 Summary of Mean Grades in Chemistry NYB for the Fall 2004 Cohort.

Group	Mean	N	Std. Deviation
No Remedial	70.3	127	18.8
Chem NYA remedial	58.4	16	18.8
Phys NYA remedial	65.0	13	7.2
Both Chem and Phys	66.3	7	6.1
Total	70.6	163	16.6

Table F.3 Summary of Mean Grades in Chemistry NYB for the Fall 2001 and Fall 2004 Cohorts

Group	Mean	N	Std. Deviation range
No Remedial	71.15	276	14.4 - 18.8
Chem NYA remedial	57.6	30	15.1 - 18.8
Phys NYA remedial	60.65	37	7.2 - 17.1
Both Chem and Phys	58.65	21	6.1
Weaker No Remediation	52.4	7	14.8
Total	61.5	170	6.1 – 18.8

APPENDIX 10

PASS RATES IN CHEMISTRY NYB

APPENDIX 10

PASS RATES IN CHEMISTRY NYB

Table G.1 Pass Rates of Introductory Chemistry NYB by Group Fall 2001 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	8	11	9	29
% Failure Rate	57.1	47.8	64.3	18.5
Pass with grade 60%-69%	2	8	4	40
% Pass grade 60%-69%	14.3	34.8	28.6	25.5
Pass grade 70-100%	4	4	1	88
% Pass grade 70-100%	28.6	17.4	7.1	56.1
% Overall Pass Rate	42.9	52.2	35.7	81.5
Average Grade	57	62.1	68.5	72.3
Std. Deviation	15.2	16	20.6	15.8
Total Students	14	23	14	157

Table G.2 Pass Rates of Introductory Chemistry NYB by Group Fall 2004 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	7	1	1	11
% Failure Rate	43.8	7.7	14.3	8.6
Pass with grade 60%-69%	5	9	3	35
% Pass grade 60%-69%	31.3	69.2	42.9	27.3
Pass grade 70-100%	4	3	3	82
% Pass grade 70-100%	25	23.1	42.9	64.1
% Overall Pass Rate	56.3	92.3	85.7	91.4
Average Grade	60.5	59.2	61.7	72.89
Std. Deviation	12.4	17	11.4	14
Total Students	16	13	7	128

Summary Table G.3 Pass Rates of Introductory Chemistry NYB by Group for the Fall 2001 and 2004 Cohort

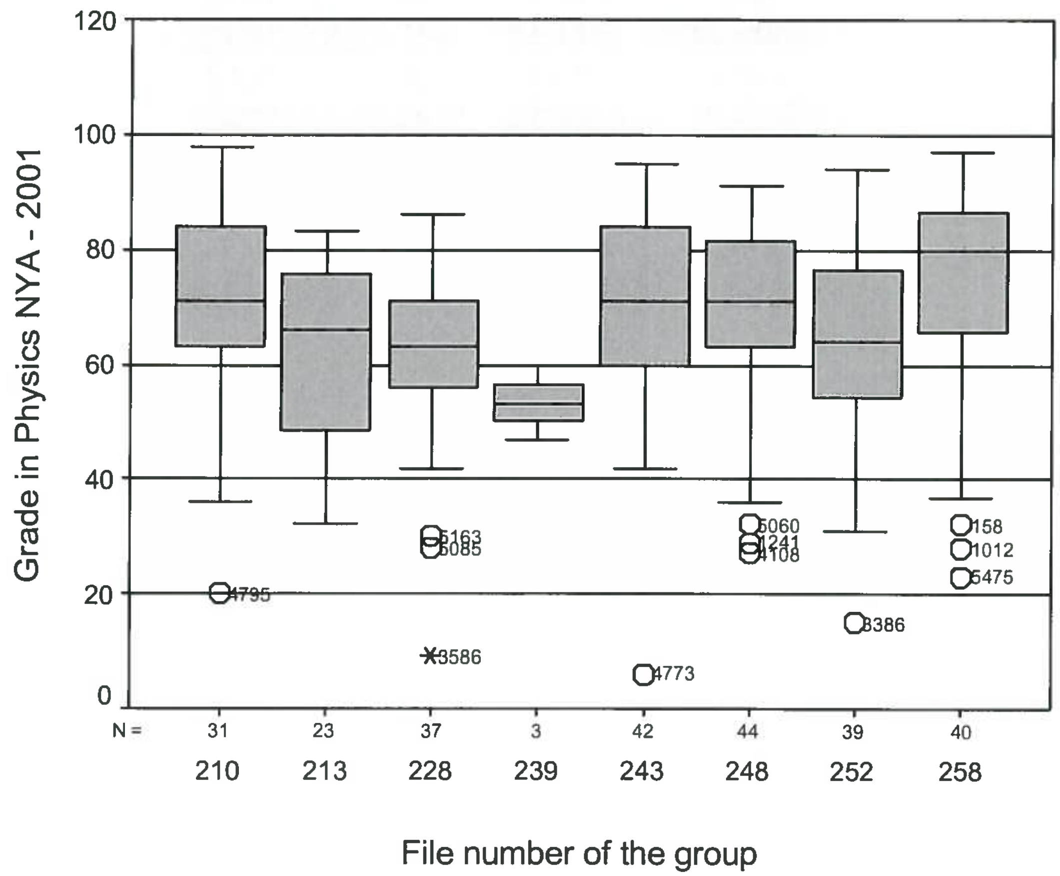
Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	15	12	10	40
% Failure Rate	50.4	27.8	39.3	13.5
Pass with grade 60%-69%	7	17	7	75
% Pass grade 60%-69%	22.8	52.0	35.7	26.4
Pass grade 70-100%	8	7	4	170
% Pass grade 70-100%	26.8	20.2	25.0	60.1
% Overall Pass Rate	49.6	72.2	60.7	86.5
Average Grade	58.6	60.7	65.1	72.6
Total Students	30	36	21	285

APPENDIX 11

THE PERFORMANCE IN PHYSICS NYA BY SECTION

APPENDIX 11

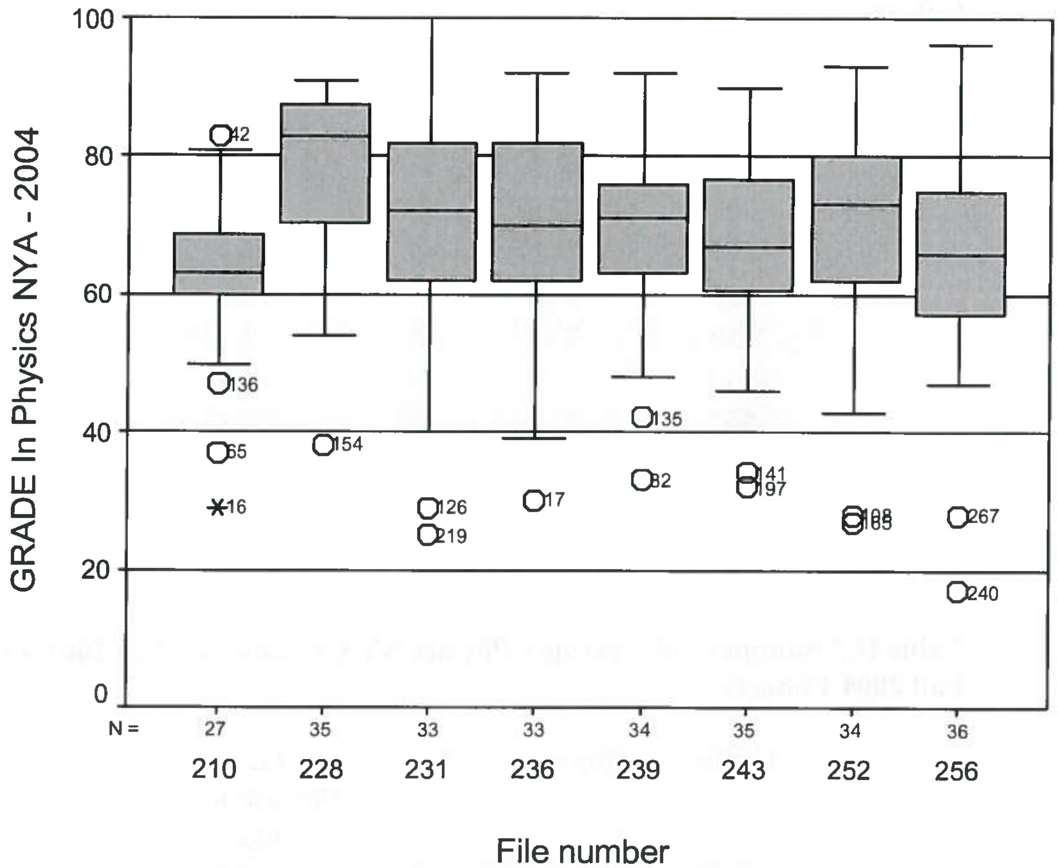
THE PERFORMANCE IN PHYSICS NYA BY SECTION



Box Plot H.1 Fall 2001 Physics NYA Grades by Section represents the range of grades for all sections of Physics NYA for the 2001 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. File number 228 is the ELC section. All remaining file numbers are the regular students.

Table H.1 Average Physics NYA Scores by Section for the Fall 2001 Cohort

File Number	Mean	N	Std. Deviation
210	71.4	31	16.8
213	61.3	23	16.5
228 ELC	61.2	37	16.1
239	53.3	3	6.5
243	69.2	42	17.4
248	68.4	44	16.2
252	63.9	39	18.5
258	73.9	40	19.5
Total	67.2	259	17.7



Box Plot H.2 Fall 2004 Physics NYA Grades by Section represents the range grades for all sections of Physics NYA for the 2001 cohort. It shows the grade distribution by section using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included. File number 243 is the ELC section. All remaining file numbers are the regular students.

Table H.2 Average Physics NYA Scores by Section for the Fall 2004 Cohort

File Number	Mean	N	Std. Deviation
210	61.9	27	11.8
228	77.3	35	13.3
231	70.7	33	17.0
236	68.8	33	16.1
239	70.2	34	13.1
243 ELC	67.2	35	13.5
252	70.5	34	15.5
256	64.7	36	15.4
Total	69.23	267	15.031

Table H.3 Summary of Averages Physics NYA Grades for Fall 2001 and Fall 2004 Cohorts

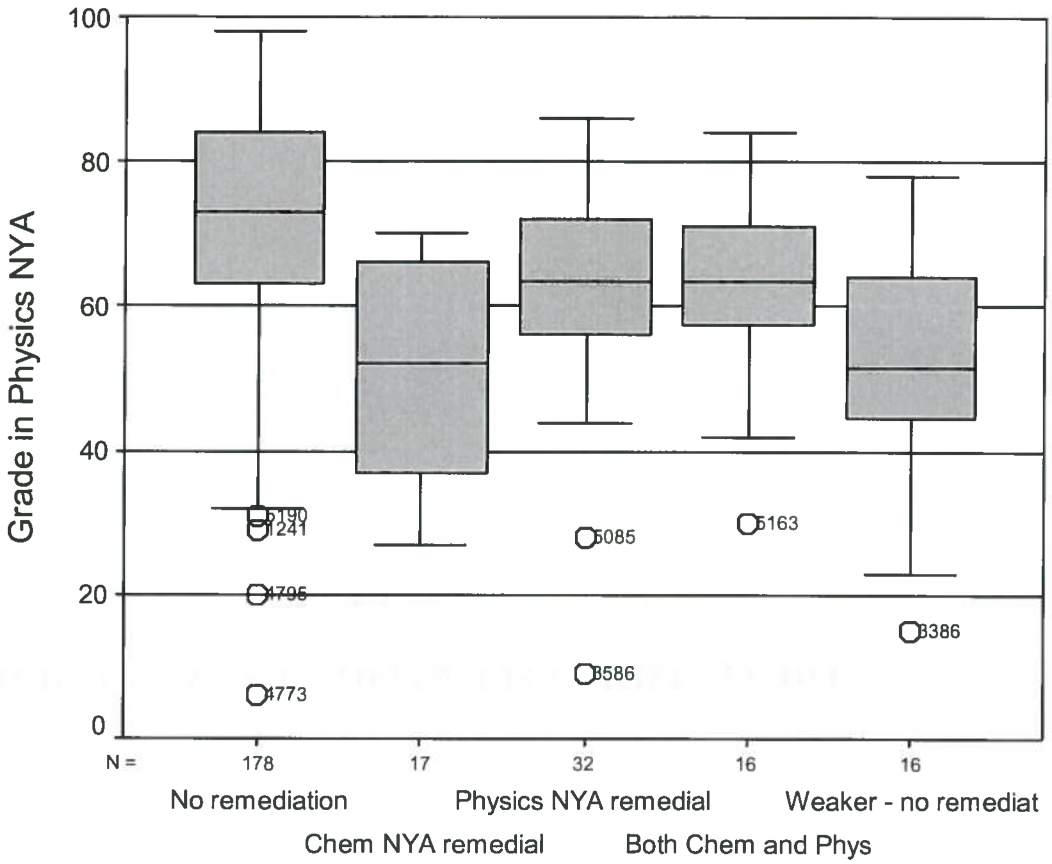
Group	Mean	N	Std. Deviation Range
ELC	64.2	72	13.5 -16.1
Regular Students	68.0	454	11.7-17.7

APPENDIX 12

THE PERFORMANCE IN PHYSICS NYA BY GROUP

APPENDIX 12

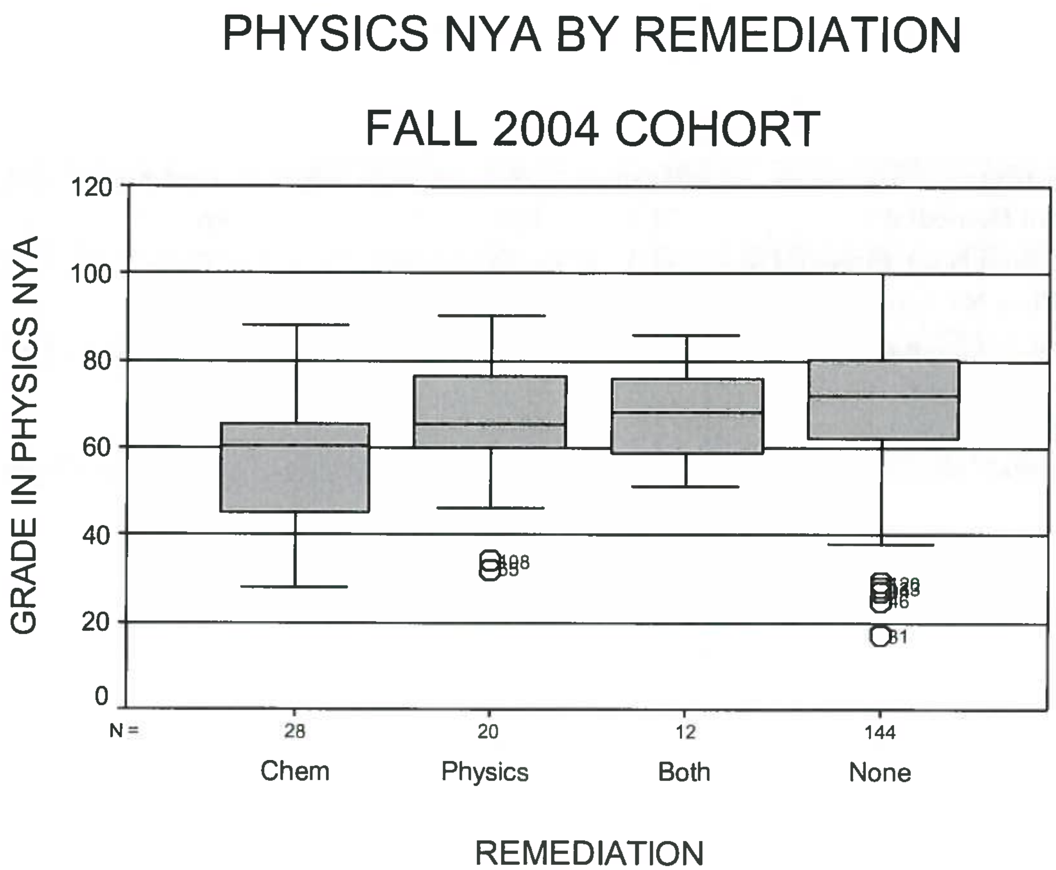
THE PERFORMANCE IN PHYSICS NYA BY GROUP



Box Plot I.1 Physics NYA Fall 2001 Cohort represents the range of the Physics NYA grades for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table I.1. Summary of Mean Grades in Physics NYA for the Fall 2001 Cohort

Group	Mean	N	Std. Deviation
No Remedial	71.6	178	16.6
Chem NYA remedial	51.1	17	15.0
Phys NYA remedial	61.9	32	15.8
Both Chem and Phys	62.9	16	14.2
Weaker no Remediation	50.8	16	17.6
Total	67.2	259	17.7



Box Plot I.2 Physics NYA Fall 2004 Cohort represents the range of the Physics NYA grades for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table I.2 Summary of Mean Grades in Physics NYA for the Fall 2004 Cohort

Group	Mean	N	Std. Deviation
No Remedial	70.5	144	14.9
Chem NYA remedial	57.7	28	17.1
Phys NYA remedial	65.9	20	16.0
Both Chem and Phys	68.1	12	20.6
Total	68.1	204	15.5

Table I.3 Summary of Mean Grades in Physics NYA for the Fall 2001 and 2004 Cohorts

Group	Mean	N	Std. Deviation Range
No Remedial	71.1	322	14.9-16.6
Chem NYA remedial	54.4	45	15.-17.1
Phys NYA remedial	63.9	52	15.8-16
Both Chem and Phys	65.5	28	14.2-20.6
Weaker no Remediation	52.4	7	17.6
Total	61.5	463	14.2- 20.6

APPENDIX 13

PASS RATES OF PHYSICS NYA BY GROUP

APPENDIX 13

PASS RATES OF PHYSICS NYA BY GROUP

Table J.1 Statistical Descriptive for the Fall 2001 Cohort

	Remediation			Statistic	Std. Error
Grade Numeric	No remedial	Mean		69.76	1.258
		95% Confidence Interval for Mean	Lower Bound	67.28	
			Upper Bound	72.24	
		5% Trimmed Mean		70.82	
		Median		72.00	
		Variance		310.245	
		Std. Deviation		17.614	
		Minimum		6	
		Maximum		98	
		Range		92	
		Interquartile Range		22.75	
		Skewness		-.895	.174
		Kurtosis		.799	.346
	Chem NYA remedial	Mean		51.12	3.646
		95% Confidence Interval for Mean	Lower Bound	43.39	
			Upper Bound	58.85	
		5% Trimmed Mean		51.41	
		Median		52.00	
		Variance		225.985	
		Std. Deviation		15.033	
		Minimum		27	
		Maximum		70	
		Range		43	
		Interquartile Range		29.50	
		Skewness		-.152	.550
		Kurtosis		-1.668	1.063
	Phys NYA remedial	Mean		62.07	2.889
		95% Confidence Interval for Mean	Lower Bound	56.16	
			Upper Bound	67.97	
		5% Trimmed Mean		63.39	
		Median		63.50	
		Variance		250.340	
		Std. Deviation		15.822	
		Minimum		9	

				Statistic	Std. Error
		Maximum		86	
		Range		77	
		Interquartile Range		15.50	
		Skewness		-1.499	.427
		Kurtosis		3.584	.833
	Both chem and Phys	Mean		62.94	3.548
		95% Confidence Interval for Mean	Lower Bound	55.38	
			Upper Bound	70.50	
		5% Trimmed Mean		63.60	
		Median		63.50	
		Variance		201.396	
		Std. Deviation		14.191	
		Minimum		30	
		Maximum		84	
		Range		54	
		Interquartile Range		14.75	
		Skewness		-.764	.564
		Kurtosis		.686	1.091

STEM-AND-LEAF PLOTS FOR PHYSICS NYA 2001 COHORT

```
Grade Numeric Stem-and-Leaf Plot for
COURSE2= No remedial

 Frequency    Stem &  Leaf

     4.00 Extremes    (=<23)
     2.00        2 .  89
     4.00        3 .  1222
     4.00        3 .  6779
     4.00        4 .  2244
     6.00        4 .  556679
    11.00        5 .  00011223344
     4.00        5 .  5666
    26.00        6 .  00000000011222333333344444
    21.00        6 .  555666666677778888889
    24.00        7 .  000011111122223333334444
    19.00        7 .  5556666677777788899
    24.00        8 .  000000012222333333444444
    22.00        8 .  5555556666666777788889
    14.00        9 .  01111111233344
     7.00        9 .  5677778

 Stem width:        10
 Each leaf:       1 case(s)
```

```
Grade Numeric Stem-and-Leaf Plot for
COURSE2= Chem NYA remedial

 Frequency    Stem &  Leaf

     1.00        2 .  7
     4.00        3 .  2467
     3.00        4 .  035
     1.00        5 .  2
     6.00        6 .  014666
     2.00        7 .  00

 Stem width:        10
 Each leaf:       1 case(s)
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```
Grade Numeric Stem-and-Leaf Plot for
COURSE2= Phys NYA remedial

 Frequency    Stem &  Leaf

     2.00 Extremes    (=<28)
     1.00        4 .  4
     1.00        4 .  7
     2.00        5 .  13
     3.00        5 .  666
     6.00        6 .  000011
     4.00        6 .  6888
     6.00        7 .  001133
     2.00        7 .  67
     2.00        8 .  03
     1.00        8 .  6

 Stem width:        10
 Each leaf:       1 case(s)
```

```
Grade Numeric Stem-and-Leaf Plot for
COURSE2= Both chem and Phys

 Frequency    Stem &  Leaf

     1.00 Extremes    (=<30)
     2.00        4 .  28
     1.00        5 .  5
     6.00        6 .  003347
     4.00        7 .  0118
     2.00        8 .  14

 Stem width:        10
 Each leaf:       1 case(s)
```

Table J.2 Pass Rates of Physics NYA by Group Fall 2001 cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	9	9	4	35
% Failure Rate	52.9	30.0	25.0	17.9
Pass with grade 60%-69%	6	10	6	47
% Pass grade 60%-69%	35.3	33.0	37.5	24.0
Pass grade 70-100%	2	11	6	110
% Pass grade 70-100%	11.8	36.7	37.5	56.1
% Overall Pass Rate	47.1	69.7	75.0	80.1
Average Grade	51.1	62.1	62.9	70.0
Std. Deviation	15.0	15.8	14.2	17.6
Total Students	17	30	16	196

Table J.3 Statistical Descriptive for the Fall 2004 Cohort

	REMEDIATION			Statistic	Std. Error
PHYNYA	Chem	Mean		57.71	2.961
		95% Confidence Interval for Mean	Lower Bound	51.64	
			Upper Bound	63.79	
		5% Trimmed Mean		57.67	
		Median		60.50	
		Variance		245.545	
		Std. Deviation		15.670	
		Minimum		28	
		Maximum		88	
		Range		60	
		Interquartile Range		22.25	
		Skewness		-.131	.441
		Kurtosis		-.367	.858
	Physics	Mean		65.85	3.486
		95% Confidence Interval for Mean	Lower Bound	58.55	
			Upper Bound	73.15	
		5% Trimmed Mean		66.39	
		Median		65.50	
		Variance		242.976	
		Std. Deviation		15.588	
		Minimum		32	
		Maximum		90	
		Range		58	
		Interquartile Range		17.25	
		Skewness		-.723	.512
		Kurtosis		.369	.992
	Both	Mean		68.08	3.151
		95% Confidence Interval for Mean	Lower Bound	61.15	
			Upper Bound	75.02	
		5% Trimmed Mean		68.04	
		Median		68.50	
		Variance		119.174	
		Std. Deviation		10.917	
		Minimum		51	
		Maximum		86	
		Range		35	
		Interquartile Range		20.00	
		Skewness		-.039	.637
		Kurtosis		-.854	1.232
	None	Mean		70.47	1.257

	95% Confidence Interval for Mean	Lower Bound	67.98	
		Upper Bound	72.95	
	5% Trimmed Mean		71.47	
	Median		72.00	
	Variance		227.425	
	Std. Deviation		15.081	
	Minimum		17	
	Maximum		100	
	Range		83	
	Interquartile Range		18.75	
	Skewness		-1.021	.202
	Kurtosis		1.774	.401

STEM-AND-LEAF PLOTS PHYSICS NYA FALL 2004 COHORT

```
PHYNYA Stem-and-Leaf Plot for
REMED= Chem

 Frequency    Stem &  Leaf

     1.00        2 .  8
     3.00        3 .  039
     4.00        4 .  1237
     3.00        5 .  024
    11.00        6 .  00013344447
     4.00        7 .  1146
     2.00        8 .  78

 Stem width:   10
 Each leaf:       1 case(s)
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```
PHYNYA Stem-and-Leaf Plot for
REMED= Physics

 Frequency    Stem &  Leaf

     2.00 Extremes    (=<34)
     1.00        4 .  6
     1.00        5 .  5
     7.00        6 .  0014556
     5.00        7 .  22358
     3.00        8 .  117
     1.00        9 .  0

 Stem width:   10
 Each leaf:       1 case(s)
```

```
PHYNYA Stem-and-Leaf Plot for
REMED= Both

 Frequency    Stem &  Leaf

     3.00        5 .  155
     3.00        6 .  357
     4.00        7 .  0248
     2.00        8 .  16

 Stem width:   10
 Each leaf:       1 case(s)
```

```
PHYNYA Stem-and-Leaf Plot for
```

```
REMED= None

 Frequency    Stem &  Leaf

     6.00 Extremes    (=<29)
     1.00        3 .  8
     2.00        4 .  03
     3.00        4 .  589
     4.00        5 .  1344
     1.00        5 .  7
    25.00        6 .  0000000000001112222223444
    15.00        6 .  556666666778889
    24.00        7 .  000000111111122223334444
    25.00        7 .  5555556666667777888888899
    16.00        8 .  0011111222233334
    11.00        8 .  55557778889
     8.00        9 .  01222233
     1.00        9 .  6
     2.00       10 .  00

 Stem width:   10
 Each leaf:       1 case(s)
```

Table J.4 Pass Rates of Physics NYA by Group Fall 2004 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	11	4	3	17
% Failure Rate	39.3	20.0	25.0	11.8
Pass with grade 60%-69%	11	7	3	40
% Pass grade 60%-69%	39.3	35.0	25	27.8
Pass grade 70-100%	6	9	6	87
% Pass grade 70-100%	21.4	45.0	50.0	60.4
% Overall Pass Rate	60.7	80	75	88.2
Average Grade	57.7	65.9	68.1	70.5
Std. Deviation	15.7	15.6	10.9	15.1
Total Students	28	20	12	144

Summary Table J.5 Pass Rates of Physics NYA by Group for the Fall 2001 and 2004 Cohort

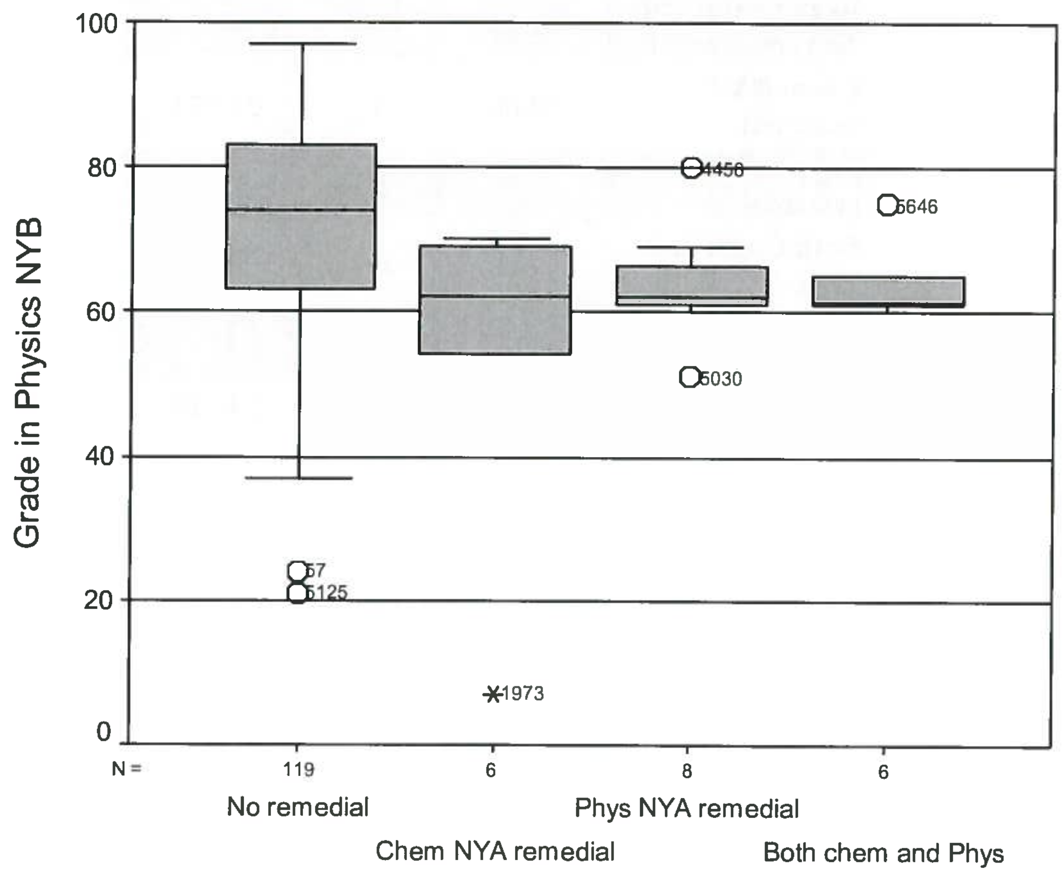
Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	20	13	7	52
% Failure Rate	46.1	25	25	14.85
Pass with grade 60%-69%	17	17	9	87
% Pass grade 60%-69%	37.3	34	31.25	25.9
Pass grade 70-100%	8	20	12	197
% Pass grade 70-100%	16.6	40.85	43.75	58.25
% Overall Pass Rate	53.9	74.85	75	84.15
Average Grade	54.4	64	65.5	70.25
Total Students	45	50	28	340

APPENDIX 14

THE PERFORMANCE IN PHYSICS NYB BY GROUP

APPENDIX 14

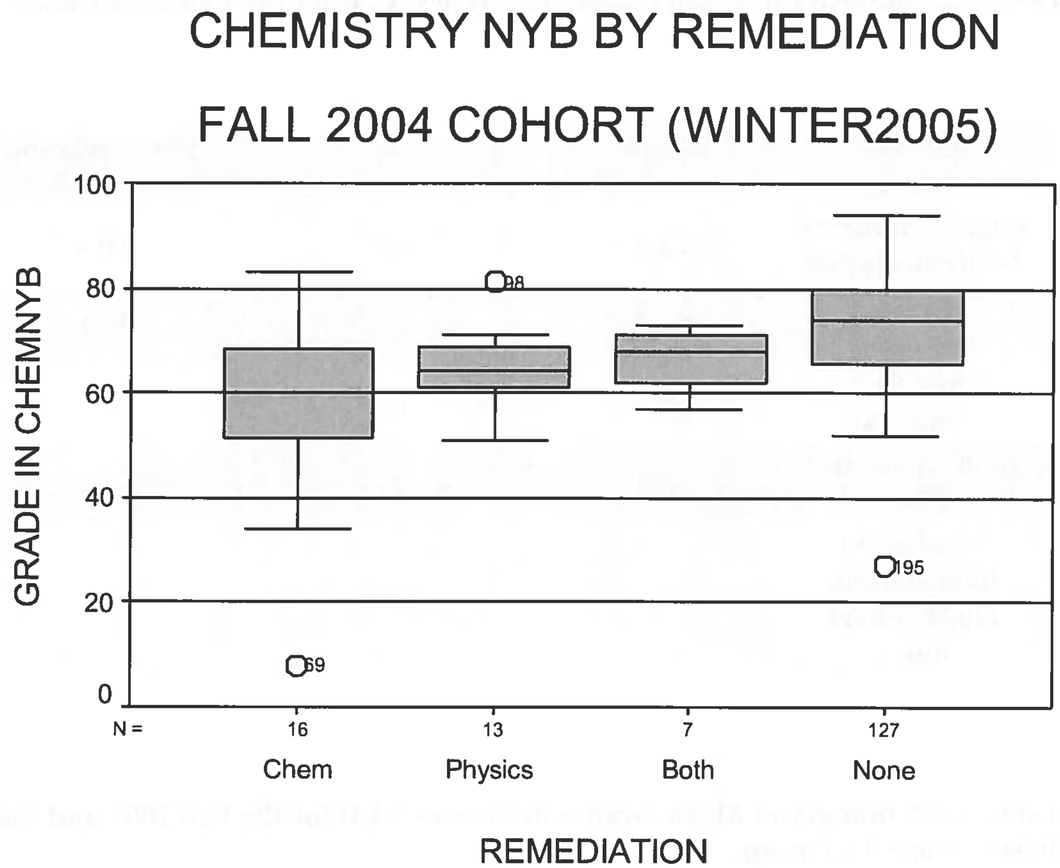
THE PERFORMANCE IN PHYSICS NYB BY GROUP



Box Plot K.1 Grades in Physics NYB Fall 2002 (Fall 2001 Cohort) represents the range of the Physics NYB grades in Fall 2002 for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation) have not succeeded to be in this group. It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table K.1 Summary of Mean Grades in Physics NYB for the Fall 2001 Cohort

Group	Mean	N	Std. Deviation
Regular students- No remediation	72.13	119	14.230
Chem NYA remedial	54.00	6	23.774
Physics NYA remedial	63.75	8	8.259
Both Chem and Phys	64.00	6	5.657
Weaker – Non - Remedial		0	
Total	70.51	139	14.726



Box Plot K.2 Grades in Physics NYB Fall 2005 (Fall 2004 Cohort) represents the range of the Physics NYB grades in Fall 2005 for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial). It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table K.2 Summary of Mean Grades in Physics NYB for the Fall 2004 Cohort

Group	Mean	N	Std. Deviation Range
Regular students No Remediation	72.6	163	10.4
Chem NYA remedial	58.4	16	18.8
Phys NYA remedial	65.0	13	7.2
Both Chem and Phys	66.3	7	6.0
Weaker no Remediation (2004 cohort only)		none	

Table K.3 Summary of Mean Grades in Physics NYB for the Fall 2001 and Fall 2004 Cohorts by Group

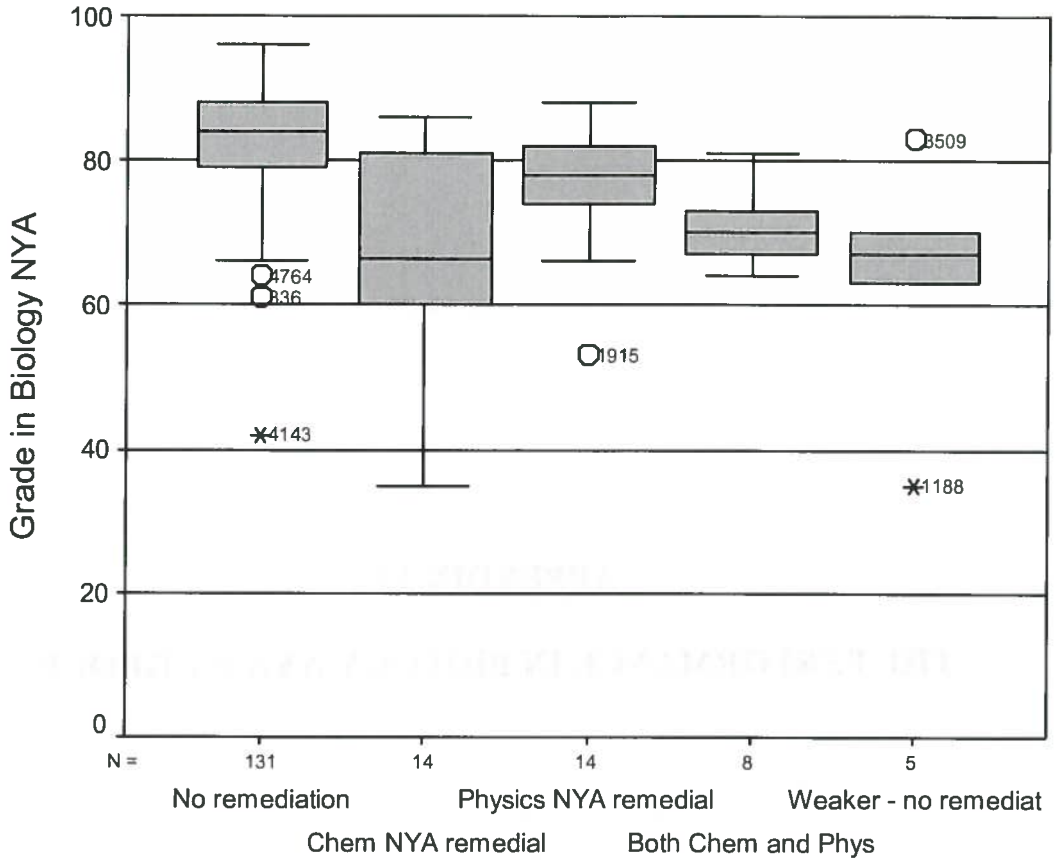
Group	Mean	N	Std. Deviation Range
No Remedial	72.3	276	14.3 – 10.4
Chem NYA remedial	57.5	30	7.2 – 15.1
Phys NYA remedial	60.6	37	7.2 – 17.2
Both Chem and Phys	58.6	21	6.1 – 13.2
Weaker no Remediation (2001 cohort only)	52.4	7	14.7

APPENDIX 15

THE PERFORMANCE IN BIOLOGY NYA BY GROUP

APPENDIX 15

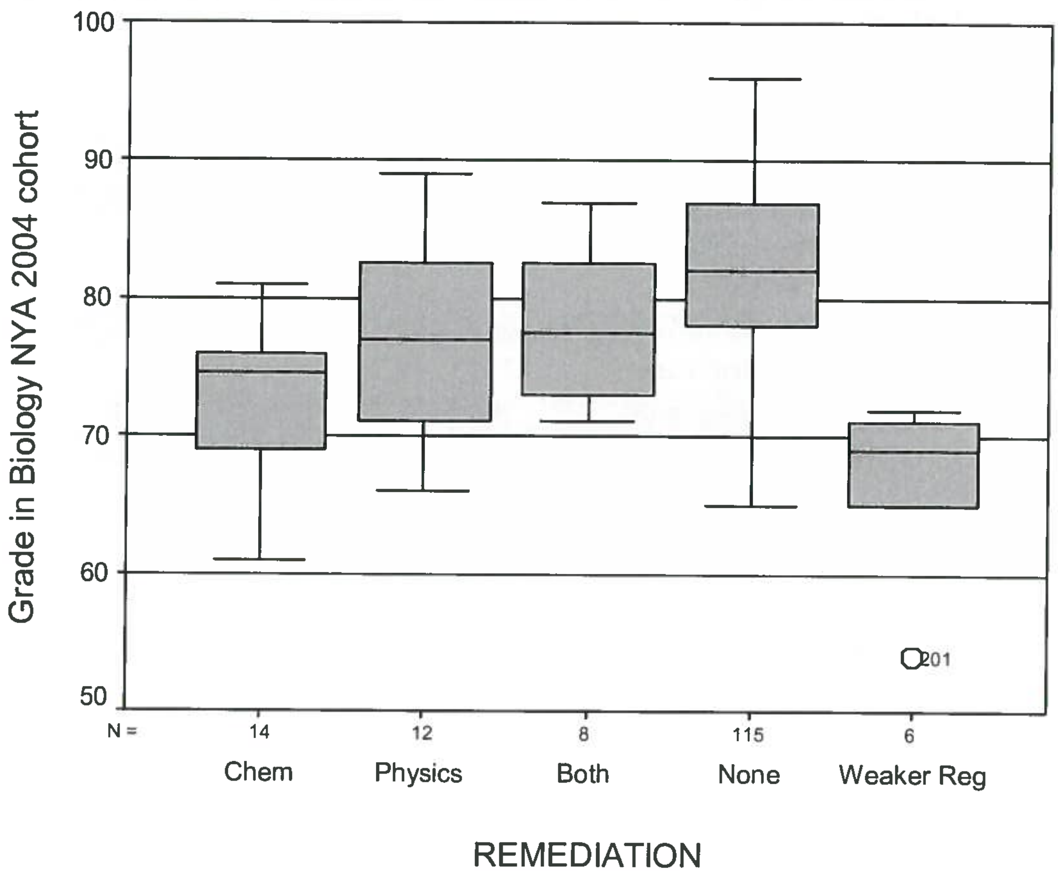
THE PERFORMANCE IN BIOLOGY NYA BY GROUP



Box Plot L.1 Grades in Biology NYA Fall 2002 (Fall 2001 Cohort) represents the range of the Biology NYA grades in Fall 2002 for the 2001 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation) have not succeeded to be in this group. It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table L.1. Summary of Mean Grades in Biology NYA for the Fall 2001 Cohort

Group	Mean	N	Std. Deviation
Chem NYA remedial	65.4	14	17.3
Physics NYA remedial	76.4	14	8.7
Both Chem and Phys	70.6	8	5.3
No remediation	83.2	131	8.2
Weaker – Non - Remedial	63.6	5	17.7
Total	79.9	172	11.2



Box Plot L.2 Grades in Biology NYA Fall 2005 (Fall 2004 Cohort) represents the range of the Biology NYA grades in Fall 2005 for the 2004 cohort as a function of the grouping within the ELC Chemistry class. The class was subdivided into those students who were placed only in the ELC in Chemistry (Chem NYA remedial); those students who were placed only in the ELC Physics (Physc NYA remedial); those students who were placed in both ELC Chemistry and Physics (Both chem. and Physc); those students who did not take any ELC courses and were enrolled in the regular stream (No remedial); those whose incoming High School average that less than 80% and had less than 65% in their Chemistry NYA but were not enrolled in any ELC (Weaker-no remediation) have not succeeded to be in this group. It shows the grade distribution by group using the median, upper and lower quartiles, and the extremes (least and greatest values). Students that dropped the course during the course withdraw period are not included.

Table L.2 Summary of Mean Grades in Biology NYA for the Fall 2004 Cohort

Group	Mean	N	Std. Deviation
Chem NYA remedial	73.4	14	5.3
Physics NYA remedial	77.2	12	7.3
Both Chem and Phys	78.0	8	5.7
No remediation	82.3	115	6.3
Weaker – Non - Remedial	66.7	6	6.7
Total	80.3	155	7.4

Table L.3. Summary of Mean Grades in Biology NYA for the Fall 2001 and Fall 2004 Cohort

Group	Mean	N	Std. Deviation
Chem NYA remedial	69.4	28	5.3 - 17.3
Physics NYA remedial	76.8	26	7.3 - 8.7
Both Chem and Phys	74.3	16	5.3-5.7
No remediation	82.75	246	6.3-8.2
Weaker – Non - Remedial	65.15	7	6.7-17.7
Total	80.1	327	

APPENDIX 16

PASS RATES OF BIOLOGY NYA BY GROUP

APPENDIX 16

PASS RATES OF BIOLOGY NYA BY GROUP

Table M.1 Statistical Descriptive for the Fall 2001 Cohort

	Remediation			Statistic	Std. Error
Grade Numeric	No remedial	Mean		82.26	.798
		95% Confidence Interval for Mean	Lower Bound	80.68	
			Upper Bound	83.83	
		5% Trimmed Mean		82.98	
		Median		83.00	
		Variance		87.177	
		Std. Deviation		9.337	
		Minimum		35	
		Maximum		96	
		Range		61	
		Interquartile Range		10.00	
		Skewness		-1.788	.207
		Kurtosis		5.978	.411
	Chem NYA remedial	Mean		65.36	4.625
		95% Confidence Interval for Mean	Lower Bound	55.37	
			Upper Bound	75.35	
		5% Trimmed Mean		65.90	
		Median		66.50	
		Variance		299.478	
		Std. Deviation		17.305	
		Minimum		35	
		Maximum		86	
		Range		51	
		Interquartile Range		25.50	
		Skewness		-.617	.597
		Kurtosis		-.688	1.154
	Phys NYA remedial	Mean		76.46	2.528
		95% Confidence Interval for Mean	Lower Bound	70.95	
			Upper Bound	81.97	
		5% Trimmed Mean		77.12	
		Median		80.00	

		Variance		83.103	
		Std. Deviation		9.116	
		Minimum		53	
		Maximum		88	
		Range		35	
		Interquartile Range		8.50	
		Skewness		-1.489	.616
		Kurtosis		2.878	1.191
	Both chem and Phys	Mean		70.63	1.899
		95% Confidence Interval for Mean	Lower Bound	66.14	
			Upper Bound	75.11	
		5% Trimmed Mean		70.42	
		Median		70.00	
		Variance		28.839	
		Std. Deviation		5.370	
		Minimum		64	
		Maximum		81	
		Range		17	
		Interquartile Range		7.00	
		Skewness		.903	.752
		Kurtosis		.955	1.481

STEM-AND-LEAF PLOTS BIOLOGY NYA FALL 2001 COHORT

```
Grade Numeric Stem-and-Leaf Plot for
Biology NYA  No remedial

 Frequency    Stem &  Leaf

     4.00 Extremes    (=<63)
      .00        6 .
     1.00        6 .  4
     5.00        6 .  66677
     1.00        6 .  9
     6.00        7 .  000011
     1.00        7 .  3
     4.00        7 .  4455
    10.00        7 .  6667777777
     7.00        7 .  8889999
    15.00        8 .  000000000111111
    16.00        8 .  2223333333333333
    10.00        8 .  4444455555
    17.00        8 .  66666667777777777
    11.00        8 .  88888888899
    12.00        9 .  000000001111
     9.00        9 .  222233333
     6.00        9 .  444455
     2.00        9 .  66

 Stem width:        10
 Each leaf:       1 case(s)
```

```
Grade Numeric Stem-and-Leaf Plot for
COURSE2= Chem NYA remedial

 Frequency    Stem &  Leaf

     2.00        3 .  56
     1.00        4 .  4
      .00        5 .
     5.00        6 .  00167
     2.00        7 .  56
     4.00        8 .  1356

 Stem width:        10
 Each leaf:       1 case(s)
```

```
Grade Numeric Stem-and-Leaf Plot for
COURSE2= Phys NYA remedial

 Frequency    Stem &  Leaf

     1.00 Extremes    (=<53)
     1.00        6 .  6
     3.00        7 .  344
     1.00        7 .  6
     5.00        8 .  00122
     2.00        8 .  58
```

```
Stem width:        10
Each leaf:       1 case(s)

Grade Numeric Stem-and-Leaf Plot for
COURSE2= Both chem and Phys

 Frequency    Stem &  Leaf

     4.00        6 .  4688
     3.00        7 .  224
     1.00        8 .  1

 Stem width:        10
 Each leaf:       1 case(s)
```

Table M.3 Pass Rates of Biology NYA by Group Fall 2001 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	3	1	0	4
% Failure Rate	21.4	7.7	0	2.9
Pass with grade 60%-69%	5	1	4	7
% Pass grade 60%-69%	35.7	7.7	50.0	5.1
Pass grade 70-100%	6	11	4	126
% Pass grade 70-100%	42.9	84.6	50.0	92.0
% Overall Pass Rate	78.6	92.3	100	97.1
Average Grade	65.4	76.5	70.6	82.3
Std. Deviation	17.3	9.1	5.4	9.3
Total Students	14	13	8	137

Table M.4 Statistical Descriptive for the Fall 2004 Cohort

	REMEDIATION			Statistic	Std. Error
BIONYA_1	Chem	Mean		73.36	1.428
		95% Confidence Interval for Mean	Lower Bound	70.27	
			Upper Bound	76.44	
		5% Trimmed Mean		73.62	
		Median		74.50	
		Variance		28.555	
		Std. Deviation		5.344	
		Minimum		61	
		Maximum		81	
		Range		20	
		Interquartile Range		7.75	
		Skewness		-.740	.597
		Kurtosis		.858	1.154
	Physics	Mean		77.17	2.117
		95% Confidence Interval for Mean	Lower Bound	72.51	
			Upper Bound	81.83	
		5% Trimmed Mean		77.13	
		Median		77.00	
		Variance		53.788	
		Std. Deviation		7.334	
		Minimum		66	
		Maximum		89	
		Range		23	
		Interquartile Range		13.75	
		Skewness		.025	.637
		Kurtosis		-.931	1.232
	Both	Mean		78.00	2.000
		95% Confidence Interval for Mean	Lower Bound	73.27	
			Upper Bound	82.73	
		5% Trimmed Mean		77.89	
		Median		77.50	
		Variance		32.000	
		Std. Deviation		5.657	
		Minimum		71	
		Maximum		87	
		Range		16	
		Interquartile Range		10.25	
		Skewness		.309	.752

	Kurtosis		-1.084	1.481
None	Mean		81.55	.654
	95% Confidence Interval for Mean	Lower Bound	80.25	
		Upper Bound	82.84	
	5% Trimmed Mean		81.78	
	Median		82.00	
	Variance		51.717	
	Std. Deviation		7.191	
	Minimum		54	
	Maximum		96	
	Range		42	
	Interquartile Range		9.00	
	Skewness		-.612	.220
	Kurtosis		1.016	.437

STEM-AND-LEAF PLOTS BIOLOGY NYA FALL 2004 COHORT

```
BIONYA_1 Stem-and-Leaf Plot for
REMED= Chem

 Frequency    Stem &  Leaf

     1.00        6 .  1
     3.00        6 .  899
     3.00        7 .  234
     5.00        7 .  55569
     2.00        8 .  01

 Stem width:   10
 Each leaf:       1 case(s)
```

```
BIONYA_1 Stem-and-Leaf Plot for
REMED= Physics

 Frequency    Stem &  Leaf

     3.00        6 .  689
     1.00        7 .  3
     3.00        7 .  668
     2.00        8 .  00
     3.00        8 .  569

 Stem width:   10
 Each leaf:       1 case(s)
```

```
BIONYA_1 Stem-and-Leaf Plot for
REMED= Both

 Frequency    Stem &  Leaf

     3.00        7 .  124
     2.00        7 .  78
     2.00        8 .  23
     1.00        8 .  7

 Stem width:   10
 Each leaf:       1 case(s)
```

```
BIONYA_1 Stem-and-Leaf Plot for
REMED= None

 Frequency    Stem &  Leaf

     1.00 Extremes    (=<54)
     2.00        6 .  55
     1.00        6 .  6
     3.00        6 .  999
```

```
    5.00        7 .  00011
    4.00        7 .  2333
    5.00        7 .  45555
    8.00        7 .  66677777
   11.00        7 .  88888888899
   18.00        8 .  000000000011111111
   16.00        8 .  2222222222233333
    8.00        8 .  44445555
   14.00        8 .  66666677777777
   10.00        8 .  8888889999
    6.00        9 .  000011
    6.00        9 .  222233
    1.00        9 .  5
    2.00        9 .  66

Stem width:    10
Each leaf:        1 case(s)
```

Table M.5 Pass Rates of Biology NYA by Group Fall 2004 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	0	0	0	1
% Failure Rate	0	0	0	>1
Pass with grade 60%-69%	4	3	0	6
% Pass grade 60%-69%	28.6	25.0	0	5.0
Pass grade 70-100%	10	9	8	121
% Pass grade 70-100%	71.4	75.0	100	99.2
% Overall Pass Rate	60.7	80	75	88.2
Average Grade	73.4	77.2	78.0	81.6
Std. Deviation	5.3	7.3	5.7	7.2
Total Students	14	12	8	121

Summary Table M.6 Pass Rates of Biology NYA by Group for the Fall 2001 and 2004 Cohort

Profile	Chemistry ELC	Physic ELC	Both Chemistry and Physics ELC	Regular students
Failures	3	1	0	5
% Failure Rate	10.7	3.9	0	>1
Pass grade 60%-69%	9	4	4	13
% Pass grade 60%-69%	32.2	16.4	25	5.1
Pass grade 70-100%	16	20	12	247
% Pass grade 70-100%	57.15	79.8	75	95.6
% Overall Pass Rate	69.7	86.2	87.5	92.8
Average Grade	69.4	76.9	74.3	82.0
Total Students	28	25	16	258

APPENDIX 17

SUMMARY OF STUDENTS ON PROFILE FOR THE 2001 AND 2004 COHORTS

APPENDIX 17

Table N.1 Summary of Students on Profile for the 2001 and 2004 Cohorts

Course and Semester	Group	Initially Registered	Total Number of Students on Profile	% on Profile
CHEM NYB				
2nd Semester	No Remedial	326	276	**84.7**
	Chem NYA remedial	52	30	**57.7**
	Phys NYA remedial	47	37	**78.7**
	Both Chem and Phys	26	21	**80.8**
	Weaker No Remediation	15	7	**46.7**
Physics NYB				
3rd Semester	No Remedial	322	211	**65.5**
	Chem NYA remedial	45	12	**26.7**
	Phys NYA remedial	52	14	**26.9**
	Both Chem and Phys	28	11	**39.3**
	Weaker No Remediation	16	0	**0.0**
Bio NYA				
3rd 'Semester	No Remedial	326	252	**77.3**
	Chem NYA remedial	52	28	**53.8**
	Phys NYA remedial	47	26	**55.3**
	Both Chem and Phys	26	16	**61.5**
	Weaker No Remediation	15	5	**33.3**

APPENDIX 18

DISTRIBUTION OF STUDENTS BY PROGRAM

APPENDIX 18

DISTRIBUTION OF STUDENTS BY PROGRAM

Table O.1 Distribution as of Winter 2003 (2001 cohort)

Program grouped second level

new remediation			Frequency	Percent
No remedial	Valid	Science	129	71.7
		Social Science	1	.6
		Commerce	22	12.2
		Creative Arts	1	.6
		Liberal Arts	1	.6
		Accounting and Management Technology	1	.6
		Publication Design and Management	1	.6
		Total	156	86.7
	Missing	System	24	13.3
	Total		180	100.0
Chem NYA remedial	Valid	Science	7	29.2
		Social Science	4	16.7
		Commerce	8	33.3
		Creative Arts	2	8.3
		Liberal Arts	1	4.2
		Computer Science Technology	1	4.2
		Total	23	95.8
	Missing	System	1	4.2
	Total		24	100.0
Phys NYA remedial	Valid	Science	15	55.6
		Social Science	2	7.4
		Commerce	4	14.8
		Computer Science Technology	2	7.4
		Total	23	85.2
	Missing	System	4	14.8
	Total		27	100.0
Weaker - no remediation	Valid	Science	5	33.3
		Social Science	1	6.7
		Commerce	5	33.3
		Computer Science Technology	1	6.7
		Total	12	80.0
	Missing	System	3	20.0
	Total		15	100.0
Both chem and Phys	Valid	Explorations science	1	7.7
		Science	8	61.5
		Commerce	2	15.4
		Total	11	84.6
	Missing	System	2	15.4
	Total		13	100.0

Table O.2 Distribution as of Winter 2006 (2004 cohort)

Program w2006

REMEDIATION			Frequency	Percent
Chem	Valid		3	10.7
		200.B1	4	14.3
		200.B2	10	35.7
		300.AA	1	3.6
		300.AB	8	28.6
		300.AP	1	3.6
		300.BB	1	3.6
		Total	28	100.0
Physics	Valid		1	5.0
		200.B1	9	45.0
		200.B2	5	25.0
		300.AB	1	5.0
		300.BB	2	10.0
		300.AS	1	5.0
		300.WC	1	5.0
		Total	20	100.0
Both	Valid	200.B1	5	41.7
		200.B2	4	33.3
		300.AB	1	8.3
		300.BB	1	8.3
		500.21	1	8.3
		Total	12	100.0
None	Valid		11	8.1
		200.B1	73	54.1
		200.B2	39	28.9
		300.AA	1	.7
		300.AB	4	3.0
		300.AP	1	.7
		300.BB	3	2.2
		300.AF	1	.7
		412.A2	1	.7
		700.B0	1	.7
		Total	135	100.0
Weaker Reg	Valid		3	23.1
		200.B1	2	15.4
		200.B2	5	38.5
		300.BB	2	15.4
		500.22	1	7.7
		Total	13	100.0

APPENDIX 19

COLLEGE CONSENT FORM

Appendix 19

COLLEGE CONSENT FORM

*The purpose of **The Academic Achievement in College Science of Less Prepared High School Students: A Longitudinal Study** research project is to determine the success of CEGEP Science students who were enrolled in a special Extended Lecture Class in either Chemistry NYA or Physics NYA or both. These students did not have the pre-requisite High School Physics and/or Chemistry grades prior to admission into the Science Program at Champlain Regional College. This study will also examine the Extended Lecture Class teachers' perspective to provide a better understanding of these students in terms of their intellectual development and behavior and whether these factors influence their performance and learning abilities in Science courses.*

Elizabeth Janik is conducting this study as a requirement of a Master's Thesis project in pursuit of a Master's Degree in Education granted by the University of Sherbrooke.

The College Administration understands that they are being asked to provide access to student High School and CEGEP grades of those who are enrolled in the Science Program at Champlain College for the 2001-2005 cohorts.

Consent Form for College Administration

The College Administration understands that authorization to use these grades is granted as long as the results of the findings will not have any identifying features such as student names or identification numbers and will be solely used for the purpose of this study. The identification numbers will only be used to track the students by sections and their subsequent Science courses. The grades will be analyzed using cross tabulations and statistical methods using SPSS software.

The College Administration may ask for information about the research project at any time, including full access to the final published results.

For clarification or further information please contact the Principle Researcher:

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F-208
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Email: ejanik@champlaincollege.qc.ca

Name:_____________________________

Signature:_________________________

Date_______________________________