The tutors mentioned that the tutees were expecting the tutors to help them (the tutees) solve the physics problems. These expectations were of a dependent nature, i.e. a need for demonstrations on how to solve the specific physics problems, to support in giving the actual answers. The tutors also viewed their own role to be more supportive contrary to their view on the tutees of acting out a demanding role. The expectation (according to the tutor) of the teaching-learning environment was for tutees to develop competencies and talents in physics problem.

The tutors could furthermore identify three areas of dissatisfaction (a starting condition for reflection) with the tutorial environment, namely a dissatisfaction relating to the physics problems, dissatisfaction relating to the feedback on tutorials from the lecturers, and dissatisfaction related to organization of the tutorial. However, the reflection-on-action abilities of the tutors were limited to contextual issues, i.e. they were not able to make inferences from their observations and interactions during the tutorials. Tutors thus aimed towards what they were taught, that is not depending on inspirations but on prescribed agendas of though (Bridgman, 1955). Freedom of thought was not allowed, i.e. not discovering an own method which may yield the correct answer. Tutors were expected to propagate equations which, even for the revolutionary discover, took years to discover (the subsequent consequences of such an approach can be viewed in the work of Govender, 1999). Tutors were thus trapped between the actual and the logical, whilst in reality the actual was more difficult to achieve than the logical. Furthermore, tutors lacked the ability to abstract

and internalise experiences and reflection in the form of a theory which they could test every time they entered a new tutoring session.

The solutions of the physics problem also involve a familiarity with mathematics (which in itself is pulled between professional mathematicians and the rest of the uses of mathematics).

Furthermore, in the context of physics tutoring, intuitive knowing is not enough for higher order reflection in the physics tutoring environment. For reflection-in-action to be meaningful there is a prerequisite for knowing-in-action. The tutors cannot be meaningfully involved with the problem solving skills needed to solve the physics problem if they do not have the necessary knowledge on how to solve the physics problem, and on how to go about assisting the tutees in their problem solving skills. They need to prepare beforehand to be meaningfully involved in solving the physics problem in the PrTM. The same applies to the tutees. Although, the tutees received theoretical assistance from the lecturer beforehand, with the tutorial merely an extension of the theory, the tutees, if the tutees lack the theoretical knowledge on the physics problem presented, the tutorial becomes meaningless unless they receive assistance from someone, in this context, the tutor. It is, however, not the aim of the tutorial to present a theoretical understanding of the physics problem only, but to link theory and practice/application. Prior knowledge is thus of equal importance to both the tutor and tutee. With regard to the tutor this prior knowledge involves knowledge on the physics

problem presented, and knowledge on how to guide a student towards problem solving in such a way that learning becomes meaningful. Not equipping tutors with the educational issues of physics tutoring is to fail to start and develop tutors' interest in tutoring.

In an effort to enhance the knowing-in-action of tutoring of the physics content, a reflective enhancement model is proposed. This aim of this model is to assist physics tutors in their reflective abilities as an attempt to make tutoring meaningful for the tutors. The reflective enhancement model is discussed in chapter five.

CHAPTER 5: SUMMARY AND CONCLUSION

5.1 Introduction

The aim of this study was to explore university Physics I tutors' conceptualization of physics I tutorials and their conceptualization on issues relating to observations and interactions during tutoring. The focus of the study can thus be summarised as an exploration of Physics I tutors' -

1. Views on becoming reflective practitioners;
2. Experiences whilst applying the Schönian model;
3. Meta-learning development and the effect of reflective practicums on other learning areas with the tutors.

A consequence of this exploration would be whether the Schönian notion of the role of reflection in the tutoring contexts was extended meaningfully to the tutor-student context.

This study was guided by the tutors' sense-making conceptualisation of the tutor-student situation; the tutors' conceptualisation of the impact of the process of reflection–in-action and reflection–on–action during and after the tutorials; the descriptive accounts given by the tutors of the strategies they utilized during student difficulties; and the descriptive accounts of the tutors' metacognitive development as a 'role-model'.

The study was introduced as a phenomenologically based study, i.e. an interpretive exploratory second-order study (see chapter 2 and 3). As a qualitative naturalistic inquiry, the study was carried out in a university setting over a period of two years.

The findings on the focus questions will now be summarised. Implications for reflective practice for tutors at the Physics department, UWC will be highlighted, upon which recommendations in the form of a reflective model will be introduced.

5.2 Tutors' conceptualization of the tutoring situation

The nature of the exploration of tutors' conceptualization of the tutoring situation involved two areas, namely that of coach-tutor and tutor-student. These conceptualizations developed through two forms of exposure, i.e. exposure to Physics I as a physics student (tutors' frame of reference as a physics student), and exposure to physics I as a tutor. The results of this exploration showed two definite views held by tutors. These views relate to both the perceived views of the students and that of the lecturers:

1. The tutors' role is to prepare students for examinations and tests. The high premium tutors put on the preparations for tests and examinations could be related back to the institution's aim that students must make the grades (Hendricks, 2001).
2. Tutors must assist students in problem solving skills. These 'problem solving skills' can be understood as the ability of the students to 'plug numbers into formulae thereby coming up with the correct answer'. Tutors subsequently considered the fact that students did not know their formulae as problematic, hence the need of tutors to present students with the formulae. According to Bowden (in Govender, 1999) it is 'inadequate to say that a student comprehends a concept if they can solve a quantitative problem'. Tutors intuitively sensed that students did not understand the

physics conceptually (confirmed through studies done by Govender, 1999), hence their need for a mathematical method to solve the physics problems. But presentation of a formula does not resolve conceptual problems. Two conclusions can be drawn from this, namely that tutors give in to students' demand, and tutors lack the repertoires available to advance towards development of conceptual understanding.

The next three perceived views of the students and lecturers were less prominent in the responses of the tutors:

1. Tutors must reinforce the knowledge of the students through discussions and applications.
2. Tutors must encourage and assist group work skills.
3. Tutors complement the work of the lecturers.

The focus of the tutors during the tutorials were mainly on the learning of pure physics, whilst the 'know how' of tutoring was less prominent. The same way that students resort to 'simplistic, elementary interpretations' of physics (Govender, 1999, p.277), the tutors' resorted to simplistic, elementary interpretations of the art of teaching. So, although tutors understood the importance of their role for conceptual development, they lacked the discourse to expand on their tutoring role from an education perspective.

Educational writers through the years developed a very firm basis on which its practitioners operated (see Chapter 2, Literature review). The only difference is the strong socio-cultural influence that makes any approach to a problem immensely uncertain. A standardised approach can never be applied to a unique teaching-learning situation and will not give a one

hundred percent success rate. The same way that science-based professions (e.g. physicist) experienced an increase in professional knowledge and practice, the same way did the art of teaching develop in terms of knowledge and practice. However, outside the boundaries of the application of rigid scientific methods, a disregard for the teaching of the art of physics exists. By implication the teaching of a discipline includes the discipline, i.e. no teaching is independent of some 'subject'. So, although it may appear as if two apparently conflicting domains were merged, i.e. the art of teaching physics (which has a very strong socio-cultural influence), and the art of doing physics (an acclaimed specialised domain involving the application of rigorous scientific theory and technique), the study of physics as a domain can never be done with a disregard for the teaching of physics. The teaching of physics involves a variety of activities, i.e. the theory introductions, practicums, tutorials, tests, assignments, and examinations. Tutorials play an important role in the assessment of the cognitive skills of physics students. The tutors consequently play an important role in the enhancement of the outcomes set for the physics course, and in supporting the work done by the lecturer. It is thus not coincidental that tutors involve themselves in the art of tutoring, whilst being involved in the study of physics.

Increasingly experts in the area of teacher training motivate their students towards reflective practices. However, being involved in any facet of teaching does not necessarily probe reflection, as this study demonstrated. The results of this study indicate that existing knowledge is very important for reflection on an advanced level. Reflection can become intuitive only if a solid theoretical background is established. Reflection without prior knowledge is much more difficult to attain then 'intuitive' reflection. In intuitive reflection

the tutors may be able to become aware of a problem, but may not be able to develop an informed repertoire about the problem, as were mentioned in the previous paragraph. Tutors experiences and approaches were also influenced by their own experiences, and their own need for change and continuation of that which worked for them.

Although the contexts in which the tutorials were executed, was authentic (that is a real life situation), it did not support the tutors movement 'from the periphery to the centre of the community of experts.' That is the tutors under investigation were never fully part of the community of experts (i.e. the lecturers). Although they were part of the community of tutors as constituted by them, they felt disempowered in their position. The professional practice of the tutors thus fell short of the boundaries of professional competence. Often professional development and competence are guided by the ability to reflect on the theory and practice of a domain. Criteria over and above those proposed by Dewey and later by Schön were needed in this particular study to encourage reflection. These criteria will be discussed next.

5.3 Extended criteria to enhance reflection in physics tutors

5.3.1 Reflection does not occur spontaneously

Schön (1983, p.182) states that reflection often occurs because a person relates one situation to another and through that develops a strategy to solve the problem, i.e. the 'seeing-as' concept. Linder et al (1997) based their study on this 'seeing-as' concept. That is, the tutors used their previous experiences to find a solution to current problems experienced by their tutoring group.

The tutors who took part in this study were initially very reluctant to participate in the reflection process. In fact they were reluctant to take part in any form of discussion during the PoTM. The tutors would proceed with the calculations associated with the problems despite attempts to involve them in discussion around the teaching aspects. The possibility exists that the tutors did not 'see any difficulties' during their interaction with the students as the students' reactions might have been familiar to the tutors, i.e. the tutors experienced the same kind of 'problems/difficulty', and it is therefore not a 'problem' to have those 'difficulties' as it is 'normal'. Often the coach and the researcher would be involved in a discussion for the entire session. Probing the tutors as encouragement towards active involvement was often unsuccessful. However, the coach and researcher continued their discussion, modelling to the tutors the process of reflection-on-action. The modelling was thus intended to demonstrate to tutors the process of reflection designed for this study specifically. Not only was the process of reflection modelled to the tutors, but they were also by choice observing participants. Identifying the problems experienced by the students and trying to find a solution to assist the students in solving the problems did however, not occur spontaneously with the tutors.

The conclusion can be drawn that this study does not confirm Schöns' notion that reflection occurs intuitively, at least not the kind of reflection needed in a pure science academic teaching and learning environment. In fact, a special effort is required by the tutor to solve a problem that was identified.

Also, according to the review on the work of Lave and Wenger (p.45) which suggest that knowledge and skill develop through active engagement with an activity, this study suggests the opposite. This study suggests that theoretical knowledge is important. From the theoretical knowledge will the practical knowledge and skill develop. The training for tutors should thus be built to expand and develop the existing knowledge and experiences of the tutors. The tutor thus needs a willingness to step into the problematic situation and impose a frame onto the problem in order to solve it. Thereafter may an error of interpretation be identified which may in turn, provoke reflection.

5.3.2 Reflection needs to be guided

The process of meaningful reflection is likely to occur if it relates to a specific context. Every context has its own aims, objectives, rules and standards. Given the position held by the tutors in the academic institution it is expected of them to move with the boundaries set by the institution. Whether the tutor and student are involved in a process of joint experimentation, follow-me or hall-of-mirrors the process will be driven by the aims of the context. These aims may, however, also be a negative border for reflection. The creativity of the tutor may be limited by these aims and objectives. However, without these boundaries, reflection becomes a borderless process of the mind. Thought processes may jump from one issue to another and pulling the strings together may be an exhaustive process, impeding meaningful reflection. For initial reflection, boundaries must be clear, and from there advanced reflection may follow. Within these boundaries various branches may exist. For instance, the success

associated with good academic performance by tutees can never be reflected on outside the boundaries of the socio-cultural background of the tutees.

However, each session of interaction between a tutor and a coach has its own aims and objectives where specific outcomes are envisioned for that tutor. Reflection will thus be guided by specific tutoring aims, stretching wider to the overall aims and objectives set out by the department and institution.

However, the 'academic neglect' Hammersley (2005) refers to (see p. 46) was addressed to some extend by the modelling process between the researcher and coach. This became a familiar activity to the tutors and gradually, as the tutors gained more knowledge and started to model the unfamiliar on the familiar, i.e. as the knowledge on reflection developed through modelling, they could imitate the reflection process. As transfer became more successful improved participation started to develop (see p.44).

5.3.3 Reflection is knowledge dependent

A further important issue for reflection is knowledge of the issue being reflected upon. If a specific issue is of no importance to the reflective practitioner, meaningful reflection may take longer to occur. Although, according to Entwistle (1996), reflection is the decisive feature in facilitating the experiential learning process, knowledge formation cannot occur without the co-existence of theory and practice in tutoring.

From the data it is evident that the tutors reflected mostly on technical aspects such as the group dynamics, but lacked teaching descriptors to explicitly describe their observations and views (Van Manen, 1977). For the purpose of this dissertation 'technical aspects' refers to the tutors references of students' inability to, for example, draw graphs, and use formulas. Few references were made to the physics understanding of the students. The references that were referred to were of a low order. This can be ascribed to the fact that tutors had very little academic knowledge on the theory and practice of teaching, and were more focussed on the theory and application of physics. The tutors had no repertoire on teaching to draw on. The only repertoire that they could draw on was that developed from their own experiences. The knowledge on teaching the tutor brought to the situation (i.e. their knowledge-in-action) was limited, subsequently affecting their level of reflection. But not only that, it also affected the willingness of the tutors to enter into the process of reflection, as showed by this study. In this study it was the lack of a frame of reference which paralysed reflection by the tutors. The tutors needed some element of familiar repertoire to express their reflective abilities. Reflection is thus highly linguistic dependent (Schön 1983, p.276), where 'linguistic' in this context specifically refers to vocabulary that describes aspects of mental activity not commonly associated with everyday physics.

Secondly, the peripheral entry of the tutors into the world of experts (i.e. physicist) required very little involvement with the administrative part of tutoring. Value judgements and assumptions did not form an inherent part of the tutors' activity. Through continuous exposure to the teaching environment tutors may eventually gain enough practical knowledge to assist them, but it is highly unlikely for this situation as the turn over rate of tutors is too

high. They are full time students who upon completion of their degree leave the university to find employment. Not enough opportunity thus exists for the tutors to develop a repertoire through experience. A broader theoretical knowledge on educational issues seems preferable for this situation. Therefore, unlike the reflective practitioner in a community of experts, the tutors cannot be assumed to act out knowledge-gain-through-experience, i.e. knowing-in action.

Relating the above arguments to the traditional notion propagating a conducive environment for reflection, a reflective enhancement model is suggested to encourage and support the reflective ability in physics tutors working with first-year physics students. This model will now be discussed in section 5.4.

5.4 Recommendations - The reflection enhancement model

The results of this study point towards the conclusion that the physics tutors involved in this study were able to reflect-in-action and reflect-on-action when certain conditions existed. These basic conditions are reflected in what the researcher calls the 'reflection enhancement model' (see Figure 5.1). The basic premise of the reflection enhancement model is that reflection is not an automatic process, but highly knowledge dependent and needs to be guided in its initial stages. This model suggests that there are three conditions which need to be met to enhance the reflective process, namely, context, dialectic and vision. These conditions are discussed in section 5.5.1, 5.5.2 and 5.5.3 respectively.

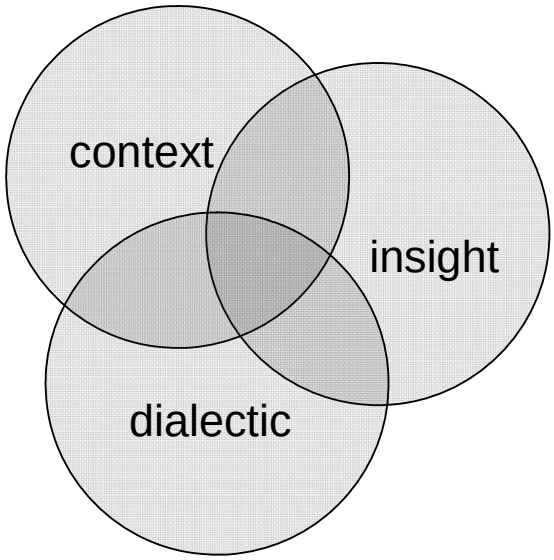

Figure 5. 1: The reflection enhancement model

5.4.1 Context

Weaknesses in education systems are often blamed on the lack of skills in various areas. However, the context of the education system is often ill-prepared, the logic for the process is not appreciated by everyone, and the vision is one-sided. The speech delivered by Ramaphele (2008) at the living newspaper symposium in Cape Town captured this notion beautifully:

'We have chosen the worst curriculum policy that you can ever imagine. Not a single country in this world…has succeeded. Canada tried it…The United Kingdom, the Netherlands and New Zealand tried it, they dumped it. Not us. No. If we make a mistake, we keep making it."

The context which reflections are often initiated in, are not necessarily conducive to or favourable for reflection, especially in a theory-driven context. Reflection-in-action is about the on-the-spot emerging actions, criticizing, restructuring and testing of intuitive understanding of experienced phenomena, often taking the form of a reflective conversation

with the situation (Schön 1983, p.241). The unreflective way in which our education system has been allowed to become a betrayal of the education struggle; the sterile formalism of curricula, the constant ignorance of tertiary institutions about their own work that they put out there for publications, are but a few of the frenzied patchwork to a system we all helped to create. Hence the assumption that tutors will not be able to reflect meaningfully if they have to fear the consequences of their communication. Also exposing tutors to the practice of tutoring without any formal theoretical training on tutoring down plays the value of tutorials.

Reflection being a time-consuming process requires a vast amount of interpersonal interaction with the tutor and/or lecturer. In a tertiary institution bound by time constraints and dead lines in terms of tests and examinations, it is rather difficult to introduce a change in the system. However, unless the complications of existing systems are not addressed, very little hope exists for defining new vital directions.

For tutors to operate as reflective practitioners, requires of the context in which the tutors are involved, to move towards reflective practice. Working in a traditional environment in one module and in a reflective environment in another, may cause conflict and encourage tutors to develop a preference for one over the other. Their focus may become divided.

To be able to identify a problem and to take initiative in solving that problem, knowledge must develop and be brought to bear on the issue that involves the problem, which in turn requires basic knowledge of the issue. Reflection on the issue should occur so that new knowledge can develop. But we live in a period of disproportional change. Our context

changes continuously, and is very complex in nature. The reflection enhancement model suggests a skill that is put to use by undertaking it in a complex dynamic context.

Reflective practice also encourages a responsible attitude. The reflective practitioner must be held responsible and accountable for his/her actions, i.e. for the task of guiding and supporting a student. The responsibility of a reflective tutor is not to assist the student in viewing the physics problem the way he/she (the tutor) sees it. The responsibility of the tutor is to assist the student in seeing the physics problem as it is in reality, that is, to broaden and deepen the visual imagery of the student so that the whole can make sense to the student. The forms of reflection of the tutors do not entirely represent the practice.

5.4.2 Dialectic

Academic institutions are often hesitant to test their own position against new or existing theories, with the aim to make changes to existing structures, if the need arise. Progressively and continuously developing formal methods of argumentation, whereby existing positions can be tested against new positions, is financially straining and time consuming. As was illustrated in chapter 2 of this research work, the arena of education is characterised by a vast number of theoretical perspectives on teaching and learning. Every education institution has its own theoretical perspectives to which it subscribes and rightfully so. However, if an institution assumes that reflection will take place merely because someone has been exposed to a tutoring environment inevitably limits the effectiveness of tutorials.

Drawing on Lave, the researcher argues that reflection (as with learning) is a product of the context, activity and culture in which it is developed and used. That implies that tutoring and reflection is fundamentally intertwined (situated). The researcher further argues that the influence of reflection is too often ignored in the context of tutorials by institutions. This position held by institutions is directly related to their reluctance to implement the research findings of their own scholars (that is the gap between what they know and how it is used (Brown, Collins and Duguid, 1989). Finally it appears that there is an academic ignorance of the learning and knowledge of tutors, from there the limit number of studies initiated by institutions on the tutoring environment in the pure science. There appears to be a mismatch in the intentionality for tutorials and tutoring.

5.4.3 Vision

Lastly, there needs to be clear vision and insight into the process of reflection and the way forward of the institution or department. More often than not a tertiary institution or department has clear vision of the aims and objectives for its participants, be it students or academic staff. However these visions are aligned with the theoretical perspective it holds for its teaching-learning environment. Reflective practice, unfortunately, is one of those approaches in which one cannot be involved in, without a clear understanding and vision of the outcomes. Many of the interactions between 'coach and apprentice' will be determined by the insight and understanding of the coach. Little room is subsequently left for the tutor to create a 'comfort zone' in which an approach is developed because of specific problem recurrences. Each and every situation will and must remain unique, as each interaction will

be between two unique individuals carrying with them constant change and development as they interact with the content and with each other on a regular basis. This already underlines the conflict that already exists as highlighted above in section 5.4.1.

The reflection enhancement model in a true reflective scenario will always be in a state of flux. The system of reflective enhancement will always be reflected upon, new ideas will emerge and develop, or it may collapse and call for new reflection on action.

The reflection enhancement model further suggests a constant interplay between context, dialectic and vision. A change in one area will affect the other. The model suggests an emerging journey where new information and discoveries are constantly made that requires an adaptive approach. Technical change is also important which in effect will affect organisational effectiveness which is imperative when changes are proposed.

This study thus offers evidence that tutors do have the ability for reflection given the context, dialectic and vision are agreed upon. Through guidance, support and the development of a sound knowledge-base on the theory of education and the theory of physics, the reflective ability of the tutors has the potential to improve. The importance of judgement and skill and a clear understanding of phenomena are very important to develop a sound knowledge base, needed for reflection. These notions invariably put a high strain on the knowledge basis of our students entering universities, and on the institutions, if we consider the possibility of developing our students into reflective practitioners.

5.5 Conclusion

The findings of this study have practical implications for tutors and co-coordinators of tutorial programs. The physics tutoring program at UWC came a long way and a number of changes and interventions occurred. They have moved from the position of 'a total failure' (Hendricks, 2001) to a more structured and well-organized program.

The findings of this study suggest that the current tutoring program does not support tutors in their reflective abilities. Although tutors were able to identify areas of dissatisfaction, the nature of these dissatisfactions required more authority and autonomy for the tutor to successfully address those dissatisfactions (a potential area for further research). The study however suggests that, through support, physics tutors have the ability to become more reflective. Although Candy et al. (1985) alert us to the fact that the capacity to reflect is at different levels in different students, no reflection/ or the unreflective manner in which students approach learning in higher education seriously undermines the opportunities for developing conceptual understanding, highlighting the fact that there is a place for reflection within the tutoring environment.

This research also highlights the fact that tutors felt alienated in their position as tutors. A community of tutors is not well established at the university. The tutors thus view their tutoring positions in terms of the lecturing position of the lecturer. An exploration into the establishment of a community of tutors with their own unique culture aimed at mediating intellectual activity might be fruitful. Through such an establishment a platform is created

whereby tutors can be equipped with basic tutoring skills, namely 'reciprocity' and 'competence of service' (Hendricks, 2001), as well as basic skills needed for tutoring.

As long as the final mark obtained by the student is influenced by amongst others, the tutorial mark, one cannot leave tutors to their own devices, thereby ignoring the responsibility the institution carries towards development of all societies involved in intellectual capacity building.

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Appendix A: Example of transcribed tutorial

An example of the physics problem that was dealt with during a video recording were presented as follow:

1. A transverse sine wave of amplitude 0.10 m and wavelength 2 m travels from left to right along a long horizontal stretched string with a speed of 1 $m.s^{-1}$. Take the origin at the left end of the undisturbed string. At time t = 0 the left end of the string is at the origin and is moving downward:
   a. What is the frequency of the wave?
   b. What is the angular frequency?
   c. What is the propagation constant?
   d. What is the equation of the wave?
   e. What is the equation of motion of the left end of the string?
   f. What is the equation of motion of a particle 1.5 m to the right of the origin?
   g. What is the maximum magnitude of transverse velocity of any particle 1.5 m to the right of origin?
2. Write the equation y(x, t) describing a travelling transverse wave that propagates in the positive x direction and satisfies the following conditions:
   a. The maximum disturbance from equilibrium at any point is 1 cm.
   b. The wavelength is 2 m.
   c. The period is 0.02 s.

d. At t = 0 and x = 0.5 m, the instantaneous particle velocity is $\pi/2$ m.s^{-1} down (or negative).

Typical solutions to the above problems are-:

1. A = 0.10; m = 2 m; c = 1 m.s^{-1}. The wave propagates in the positive direction (to the right).

   a. f = c/m = 1 m.s^{-1}/2 m = 0.5 s^{-1}

   b. w = sπf = 2π (0.5 – 1) = 3.14 rad.s^{-1}

   c. k = sπ/m = 2π/2 m = 3.14 m^{-1}

   d. The wave is travelling to the right

      y (x 1t) = +/-A sin (wt - kx)

      v = sx/2t = +/- Aw cos (wt - kx)

      but t = 0, x = 0

      v = +/-Aw

      It is specified that the velocity is downward

      V = -Aw

      y (x1t) = -Asin (wt – kx)

      thus y(x1t) = - (0.10 m) sin {π(t-x)}

   e. Left end: x = 0

      y (0,t) = - (0.10 m) sin (πt)

   f. 1.5 m to right of origin: x = 1.5 m

      y (t) = - (0.10 m) sin (πt – 3/2π)

      = - (0.10 m) sin (πt – 2π + 1/2 π)

= - (0.10 m) sin (πt + 1/2 π)

= - (0.10 m) cos (πt)

g. y(x1t) = - (0.10 m) sin {π(t –x)}

vy = 2y/2t = - (0.10 m) . (π) cos {π (t-x)}

vy max when cos ( ) = +/-1

vymax = 0.314 $m.s^{-1}$

2. positive x direction: y = A sin (wt - kx - ǿ)

y = A sin {2 π (t/ - x/) + ǿ}

t = 0.025 and = 2 m

A = 0.01 m

To determine ǿ, we calculate vy and evaluate it within the given conditions:

Vy = 2y/2t (x 1t) = 2 π/t A as {2 π(t/t-x/y) + ǿ} at t = 0 and x = 0.5 m

Vy = 2 πA/t as { - π/2 + ǿ} = -2 πA/t sin ǿ = π/2

-π/2 = π sin ǿ = ǿ = -30 degrees = - π/6 radians

y(x 1t) = (0.01 m) sin 2 π { (505 –1)t – (0.5 m –1) x – (1/2)}

Appendix B: Factual account of tutorial

There were five groups of four members each in the video recording room. The groups were positioned randomly in the room to ensure freedom of movement by the tutor. The researcher decided at random on which group to focus during the video recording of the tutorial, which is then referred to in this thesis as the focus group.

0-10 minutes:

The students walk into the video room and take their respective places at the various tables. The students chose their own seats at the tables. The tutor asks the students to write their names on the exercise page.

The focus group starts working on the problem immediately. The tutor walks between the groups, observing them. Students are busy orientating themselves. While the focus group is actively involved in problem solving, the tutor attends to group three. Although the initial problem statement indicates a time t = 0, the left end of the string is at the origin and is moving downward, the students still show on their graphical presentation the wave moving upwards from its point of origin.

Group five tries to get the tutor's attention. The tutor turns his attention to group two. He does not see that group five is trying to get his attention. One student from group three (with his

girl friend who is not part of the class) enters the class ten minutes late. Group five still tries to catch the tutor's attention; he attends to the focus group (group one).

10-20 minutes:

Discussions between the tutor and the students in the focus group follow, the tutor works through the initial statement of the problem, explaining the meaning of the key concepts and information presented, addressing specifically the term 'downward'. An example of the tutor's explanation follows: "what don't you understand by downwards, a transverse sine wave what does that look like, you understand what a transverse wave is, and a sine wave where must it begin, what is the amplitude, do you understand what the wavelength is?" The tutor follows a leading approach by probing and clarifying to the students the meaning of the main concepts. He told the students they need to understand the information given to them to be able to understand the questions asked in the exercise. The students realize through this sharing of information that they have wrongly placed the direction of the origin of the wave on their graph. They continue working on the problem.

A second tutor, who is also the co-coordinator of the tutoring program for the first year physics students, walks into the room. He immediately attends to the focus group. The co-co-ordinator often enters the tutoring setting to help the tutors by assisting them during the tutoring sessions. The tutor is still assisting group five.

The co-ordinator probes the focus group on their understanding of the concepts. Students explain their understanding of the problem to the co-ordinator. The students are trying to

establish the SI units of (k). The co-ordinator asks students for the definition of (k). Students reply that it is a constant. The co-ordinator asks the students on the definition of the wave number. The students cannot give the co-ordinator an answer. The co-ordinator explains that to know something, you must know the definition of it. The students are then told that their calculation of the problem was correct. They show their excitement when hearing this comment.

20-30 minutes:

The tutor attends to group four, whilst the co-ordinator attends to group two. The co-ordinator leaves the room. The focus group is still actively involved with problem solving. There is interaction between all four members of the group; they communicate through questioning and answering each other. They are trying to solve question 1(d).

The tutor attends to group three. The co-ordinator enters once more; speaks to the tutor and leaves the room again. Tutor continues to stay with group three. One of the students in the focus group shows signs of boredom, he tries to call the tutor by raising his hand, but the tutor is standing with his back to them and cannot see him calling. The student throws his pen on the table and sits back. Gradually the students in the focus group start to work on the problem again. The students manage to get the correct formulae to solve the problem in question 1(e), i.e. –A sin (wt-kx).

Tutor attends to the focus group. Students inform tutor that they want to discuss from question 1(c) onwards. Tutor follows the same approach as previously, but this time the students

explain their reason for coming up with their specific answer. Through discussion, negotiation and clarification he leads the students to understand the next steps towards solving the problem.

The tutor left to attend to group three, then to group five, four and two respectively.

30-40 minutes:

In the focus group the students consult their notes for assistance. They go through all their various notes on transverse waves, trying to find formulae to solve the problem. Group two and five stopped working on the problem. The students in group five are each working at the problem on their own, there appears to be little or no co-operative learning taking place. In the focus group two of the students become distracted and start looking around in the room and to the other tables. One of the students is rewriting their answers on the sheet. All four students start to work on the problem co-operatively again.

The tutor attends to the focus group. The tutor guides the group through the question. The tutor tests the group's understanding of the various formulae being used so far, and the meaning of the formulae to them, through a process of questions and answers. Where students show misconceptions, the tutor would lead them by giving them the answer. Tutor left for group three.

40-50 minutes:

The students in the focus group are now really struggling with the problem, and increasingly become more distracted, especially two of the students.

One of the students in the focus group writes their solutions down on the exercise page. While he is doing that, the two other students (who were previously also distracted) are talking and singing songs. One of the students of the focus group explains his understanding of the next problem to his fellow group members. They look at the question again, trying to find a solution to the problem. In question 2 there are certain conditions given describing a travelling transverse wave. So they are trying to understand the conditions, but they misinterpret the question and use the conditions as part of the question being asked.

The tutor attends to the focus group – he indicates to them their misinterpretation of the question, which they then understood immediately. They ask the tutor about the meaning of maximum disturbance. He explained to them that it means the maximum displacement and told them that they are given the wavelength and period as well, as part of the conditions. The tutor does not get involved in the actual calculation of the problem, but focuses their attention on what they are given to assist in solving the problem. The students said 'OK' and the tutor left to spend time with group two.

50-60 minutes:

The tutor attends to group three. The focus group tries to solve question 2 co-operatively by explaining their understanding to each other. Group two packs up to leave and one of their members attend to the students in the focus group. He explains to them how to solve question

two, they listen patiently, occasionally posing a question. This student from group two goes straight into the calculation of the problem, showing the group how the formulae are derived and how the calculations should be done. The student left and the focus group continues working on question 2 and manages to solve it. Whilst one of the students is writing the answer down, the other two students (the same one's who were distracted previously) are singing and talking. Occasionally the 'scribe' struggles to substitute the symbols with numbers and then his fellow students assist him.

Group four are done and one of the students starts to play with the microphone. The tutor attends to group four and three respectively, whilst the focus group completes their final write up of their answers.

Session ends.

Appendix C: Tutors' view on students perception of the role of tutorials

The results of the post-interview are given below.

S: *It seems like they think we are there to give them answers, but as we go on they understand that we are there to help them. At first they are not so keen on the idea of having a tutor around. They think we're looking to find what's wrong, but afterwards they become quite comfortable.*

At first they expect you to give them answers and after that you become a support for them. The problem is that some students take it beyond that, and others don't care, and then you get some very dedicated students who believe you are there as a support for them.

S: *The problem is that we only have until the end of the first year and sometimes they become to dependent on one tutor.*

S: They always look for one of us whenever they are afraid to say something in class or approach the lecturer in class so they expect you, the tutor, to teach them or lecture them again. They seem to become more comfortable with the tutor than with the lecturer or even trying to understand the work. As I said some students expect you to lecture to them.

Appendix D: Tutors' view on the lecturers perception of the role of tutorials

S: For me, I enjoy doing it. It's a matter of helping and broadening knowledge so I think most of our tutors have that idea, they view it as a means to help other students.

S: I think so; I mean I read a lot. The tutorial for me is are that important in the sense that if you come up with the understanding of something, that is more important than you being able to complete the task. So, if they can cover the question here, most often it's going to come out in the exam, the same way and if you can tell them there and then they will get something right.

S: Yes, it is a preparation for the exam. That's why I say, for me it's not important that you finish, but more that you understand.

Appendix E: Tutors' view on students perception of the purpose of tutorials

S: To give students a better understanding of the work.

R: And how does it make you feel to see that they do not really understand?

S: It doesn't bother me anymore. I kind of learned over the years that some students will work and some won't and you kind of learn after a while that if they don't want to learn you can't force them and you move on.

Appendix F: Tutors' view on the lecturer's perception of the purpose of tutorials

S: Sure, they expect you to help the students understand the basics, to help them to solve problems or find the solutions and to kind of help them, its more to guide them towards a better understanding and overall view of the tutorial.

Appendix G: Tutors' view on the concept of understanding

S: *It is when they come to you the second time and you ask them something and they can recall or they can get to a certain point where you know OK I covered this work with them before and I can see they can get to that point and maybe there is something new or ya, I would say if you ask them something about the last time and they still remember that after a while they can still apply that then I know they understood something.*

Sometimes, not all the time, I say it because they learn things off by heart and sometimes you mistake that for their knowledge and understanding, so what I try to do is ask them a few different ways to check whether they still understand or you apply it to other areas to see if they understand.

Comments referring to the focus group

S: *Compared to the rest of the … they were quite … they were able to figure out things for themselves. They weren't … they started up being dependent while they were waiting for me, but as you look through you see that they got something, and there wasn't too much.*

S: *It's just that they drew my attention; otherwise I would just sit around. And if you ask them 'are you OK?' they would say 'yes'. Now you're not sure. They seem to be busy when you walk around, when you turn your back they do nothing more. They haven't gotten as far.*

S: The weaker group. If you ask them if they are OK, or if you explain to them, and you said are you ok now , are you sure, and they'll say 'yes'. But when you come back to them they are still at the same place Yes, I mean, I already spend like 15 minutes.

S: If I have time I try to start from the basics. We've been taught not to lecture, so I can only take it to a certain point. If you don't understand … In the video you can see they don't understand the basics and I couldn't help them with that, because we were taught not to lecture.

S: Yes, we are not encouraged to teach them, we can guide them but not to teach them.

Appendix H: Tutors' view on the management of tutorials

S: *I haven't done it for the past couple of tutorials. I was just getting back from (inaudible) and I didn't have enough time to prepare for this tut, and the day before I was just trying to contact Dr X, but he wasn't around, so I couldn't and I didn't know where I was going to be for that week. I think it was the usual.*

From the video it seems that you don't get the chance to spend enough time with everybody and students might be waiting for your help, but you don't see that because you're to busy with somebody else.

Not actually, because you have your back turned to them and you may be busy and they don't call you out they just raise their hand or something, so you don't know what's happening. I think I actually…the thing is that I didn't work with that group too much, or I might have worked with a few of them from the group, but as a whole I haven't worked with the group so I don't know who is the weaker…and in the end I find out that the weaker ones that I should spend more time with and the stronger groups I have spend too much time with.

We realize that when we you're going through the tut. As I said it was difficult, because you didn't know if you helped the other groups get to where they were or whether they were doing it on their own. The video helped me see that.

We don't want them too become to dependent … that's the thing, we only have an hour at most, and with five groups its like 12 minutes per group, so if you start from the basics its going to take 10 minutes that's 2 minutes left for them to actually do their work, so your contact time will then be involved.

If I have the same group today it will be to spend more attention today to the groups that I felt were weaker. So next time I will, look, I'm not based at UWC so I can't follow their lectures the way I used to, so I don't know where they are.

Appendix I: Tutoring style identified by the tutors

S: That's difficult you can't do it all the time. You can go in with an idea and then … the students, you go with the idea that, OK, you've done their work in class and the students must have an idea, I mean they've done their and you find some student that can do this, they don't need much help in certain sections and then you find some that are totally clueless and that's been the problem. You need to … you come up with an idea but then you need to change it and ... sometimes when you come with preconceptions that they would understand it or you expect them to be weak and sometimes they surprise you in their understanding. After a while yes, me personally … I mean, I've done it for 3-4 years now. For me yes, but it's not always so easy to recognize.

Ya, I guess we do, we are quite prepared, and we always have to do something you never expected. We try to cover most of the aspects. We have guidelines that we follow. We did a course with Mr X.

S: I don't think so; it may seem like that on the video, because I also noticed that it seems that I did spend a lot of time. The problem in their case was that they did the work, but their calculations were wrong, so you had to come back and go through that with them. And sometimes you get caught up in that and you can't now leave in the middle of something because the rest depends on that. So you do get caught up in that. And then they usually ask you a lot. They are more interactive than the other groups … more time with them because you can't just break away from them.

S: Group three, I've worked with a couple of them, I mean I've worked a lot with that group, or with the members of the group. They are quite strong, they know their work and they keep you busy. If you are with them they lead from one question to another.

Group one, they've got quite strong students in there, it's just that they … sometimes they become to dependent. Instead of working things out for themselves they will wait for you to come. And you will see if you watch the video, if you leave them for quite a while they will start working it out by themselves. So sometimes they do wait but they don't have to; in time you see if they wait too long they start to do that by themselves.

S: Group five … when you work with them they tell you they understand and you get an indication of ok, they now what to do. And what I try to do is I always go through it again, just to make sure and when you leave and you come back you find that they haven't always moved on from where they were, although they said that they understood it, it seems as if they did understand.

S: We found that that is one of the big problems in the exams, and I believe if you don't understand the question what you are trying to answer. There is no point in trying to answer something if you don't understand the question. Where you find that most often they get stuck is the information is already given, and now they are trying to find stuff that is already given, because they haven't read properly.

S: Yes, and that wastes a lot of time, because they are all confused because they don't know what to do, where it is already given, just that they haven't read it.

R: Your overall management of the class. There is this cooperation aspect which means that the students need to work together as a group. Do you think that you manage that well?

S: For me it is difficult sometimes, it is difficult sometimes. There is this tendency that one person writes, one person answers and the other person just checks. That's how the group usually works. So what we try to do is to get everybody involved, that's why I ask questions, then I usually ask somebody. And if they don't know than their friend, or someone, is always there that can help.

Appendix J: Tutors' view on the Schönian model

S: *It works, I really think it works. The problem is that we're not dealing with students from the same background.*

S: *Ya, so you get students that come here that have quite a good background … educational background. I mean you can see the difference between students so the model works. I do think it works but it's just the way you apply it. You can't take the model and just apply it directly and then it wouldn't work, but there are a lot of good things you can take out of it.*

S: *Isn't it a co-operative learning model?*

S: *When it comes to tutorials, I really think it works. If you apply it properly, it works.*

Appendix K: Tutors' view on group work

S: Don't allow students to dictate what happens in the group, don't let one student dominate, don't let people feel they're out, you can control by getting involved then it will work.

S: Uh, sometimes you allow one student to do, but I mean you only allow that after you know the ability of the student, you have an idea what the student is able to do, you can allow a student to do that, well basically in a group you need three or four so if one student is working by himself or herself you still have two of the other people to make up the group, but we do try to get everybody in the group involved.

S: There seems to be some … there is progress … again in my case I try to approach a group, sometimes you stop and you move on, you ask everybody, when you done to explain that back to you and I tried to get that right.

R: I saw that group five didn't work together at all.

S: There is time that you … as I said my back was turned so I don't know what's happening and when you turn around they all seem to be working, and when you get there they all try and help each other out, but when you turn around again they've gone back to the same thing. That's why it's nice to have two people working with the group. But we can't afford to do that, we don't have enough people.

S: I should try very hard to get students; I mean I spend lots of time. I spend a whole afternoon helping them but the second year you decide, the students aren't interested, why should I? … and I'd rather spend more attention to some, although they are strong, but they are willing to work and you'd rather give them your time, then to

somebody that comes there just for answers. After a while you realize that it's not worth the effort.

S: *For me personally I try not to, I never give answers. Copying … I never write, I'm to lazy to do that stuff, uhm, there are times when you have to give them the answer, I mean there is no way … I mean you think what more can I do. To them you think, do I give them the answer or do you lead them to that point and ask them to figure it out by themselves. But most of them copy, sometimes you get to a point where you have to give them the answer, because you are running out of time now or you're close to exams and you want to do other work, so you kind of give them the answer.*

S: *In the tutorials you try, OK, you go through the problem and I'll come back to you or you give them that key to help and see how far they can get. There are those students who are not very comfortable to do the work or they haven't been to lectures. Those are the one's who want you to lecture to them. You tell them you can't do that now. At some point I feel I have to give you an answer now, as you're not going to get anything done.*

S: *Yes, I do believe that the model works. There is not always time, that's where the problem comes in. For one you don't have enough time to be as precise as the model spoke. You kind of pull on whatever you can get at that time. I made a mistake in the last tutorial, that's why I had to come back to explain something to them. It's usually when you do something with them and when you go over to another group and then it strikes you that you didn't do this properly then you need to go back and that means that you spend another five minutes there, putting things right and sometimes that happens.*

Appendix L: Tutors' ability to reflect in action

S: You find that sometimes you've explained something but when you interact with another group something else creeps up and then you realize 'no wait, wait, I was wrong or I could have been wrong in the way I put something across' or sometimes you find that with one group you suddenly found a simpler way to explain that. So I try and go back and then sometimes its tedious and it gets a bit long and half-way through they lost interest so you need this new dynamic approach and they, kind off, understand easier.

S: I think it's from the experience of the years. Personally, if I find I make a mistake I try and go back. What we used to do, we used to mark the stuff ourselves so if I did make a mistake then you I don't penalises the students, because it was my mistake. If I told them something and I would mark that and then I always go back and correct that.

S: It will be nice, but as I say time would be the problem. We probably don't have somebody to do it with us. We can't expect. We can't expect Dr X is the only one that works with us and he is in charge and doesn't have the time for it. Our meetings don't have the time for something like that. Apart from us volunteering to do something it won't happen at this stage. So there isn't time for that.

S: Individually we could find time but as a group it wouldn't be possible.

S: Yes, I understood more working with them then when I did. I learned more of the stuff now. There is no understanding.