Identifying Systemic Contradictions in a Post-Graduate Astrophysics Program

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Background

➢ Astronomy and Astrophysics are designated flagship areas of research in South Africa [1].

➢ A postgraduate structure, the National Astrophysics and Space Science Programme (NASSP) hosted by the University of Cape Town South Africa, was established.

➢ After six years of the NASSP, there is limited success of South African black students graduating from the NASSP. (affective issues, general learning problems and specific content difficulties at the university).

➢ The Extended Honours Programme (EHP), a one year bridging course, has since been designed to prepare the students for the NASSP Honours programme.

Objective

Deepen understandings of the nature of the difficulties students from Historically Black Universities (HBU) [2] face as they transit from their undergraduate to graduate studies at the University of Cape Town

Methods

➢ Surveys (Epistemological beliefs assessment for Physical Sciences and identity surveys)[3]
➢ Videotaped 2nd year Electromagnetism lectures which EHP students attended
➢ 1 hour Semi structured interviews of different cohorts of EHP students
➢ Watched and transcribed video Episodes indicating that there was a contradiction

South Africa's education system

Table 1. Typical South African Higher Education Structure for Physical Sciences.

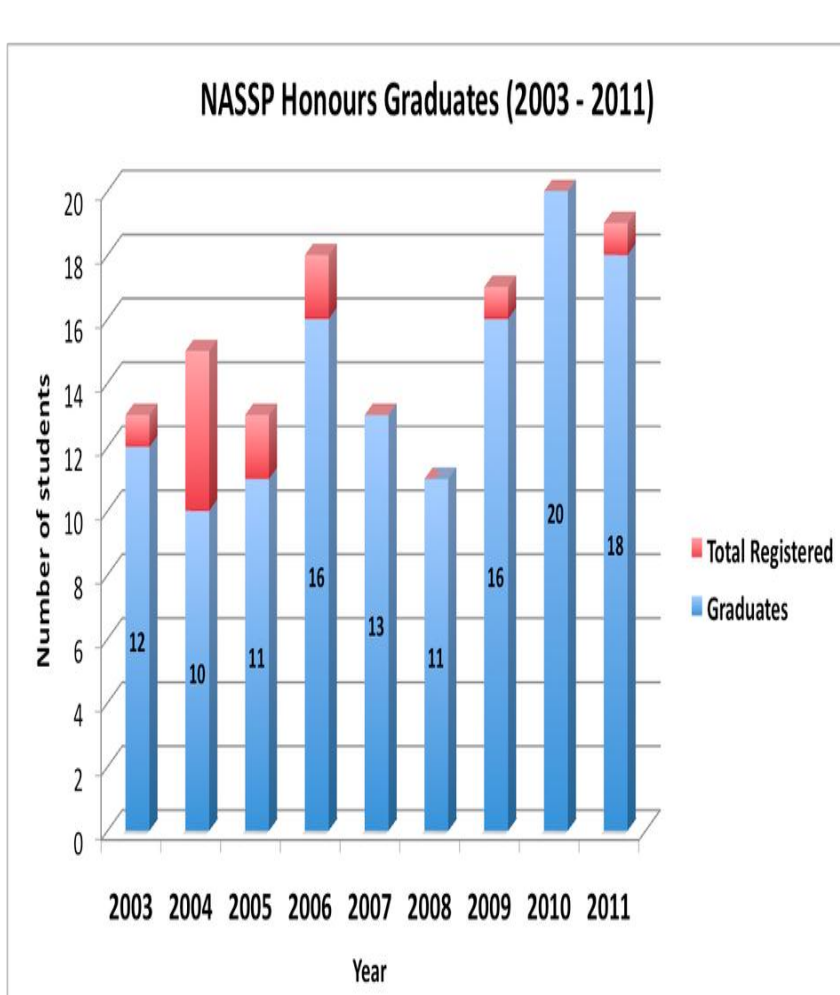| UNDERGRADUATE	EHP Bridge	GRADUATE STUDIES		
3 yr BS		1YR HONOURS	2YR MASTERS	3YRS PhD

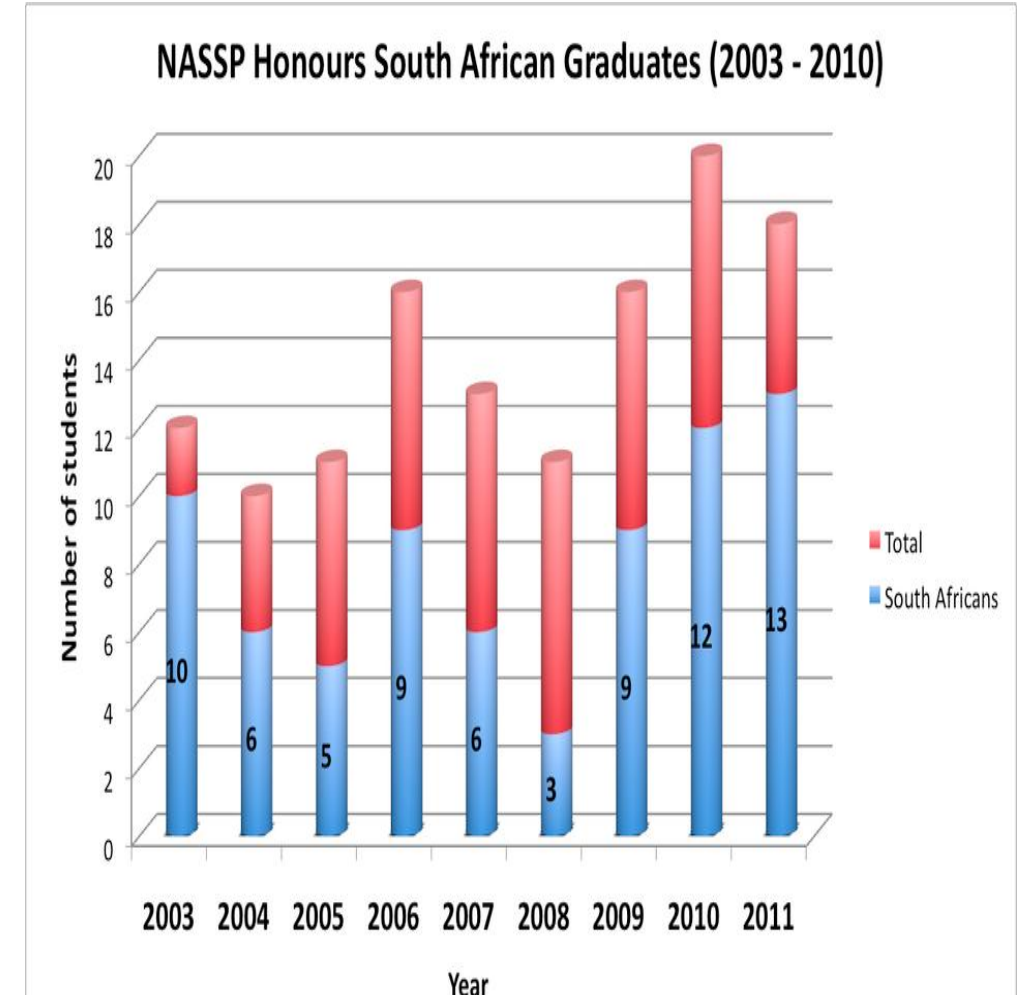Figure 1. NASSP Honours graduate 2003-20011

Figure 2. NASSP Honours South African graduates 2003-2010

References

[1] Whitelock, P. (2004). Optical Astronomy in Post-Apartheid South Africa. Cape Town: Organizations and Strategies in Astronomy.
[2] Bowen, W., Kurzweil, M., & Tobin, E. (2005). Equity and Excellence in American Higher Education. United States: University of Virginia Press.
[3] The Idea behind EBAPS. Retrieved 01 24, 2012, from http://www2.physics.umd.edu/~elby/EBAPS/idea.htm.
[4] Yamagata-Lynch, L. (2010). Activity Systems Analysis Methods for Understanding Complex Learning Environments. New York: Springer.
[5] Barab, S., Barnett, M., L, Y., Squire, K., & Keating, T. (2002). Using activity theory to understand the contradictions characterizing a technology-rich introductory astronomy course. Mind, Culture, and Activity, 9(2), 76-107,

Theoretical perspective
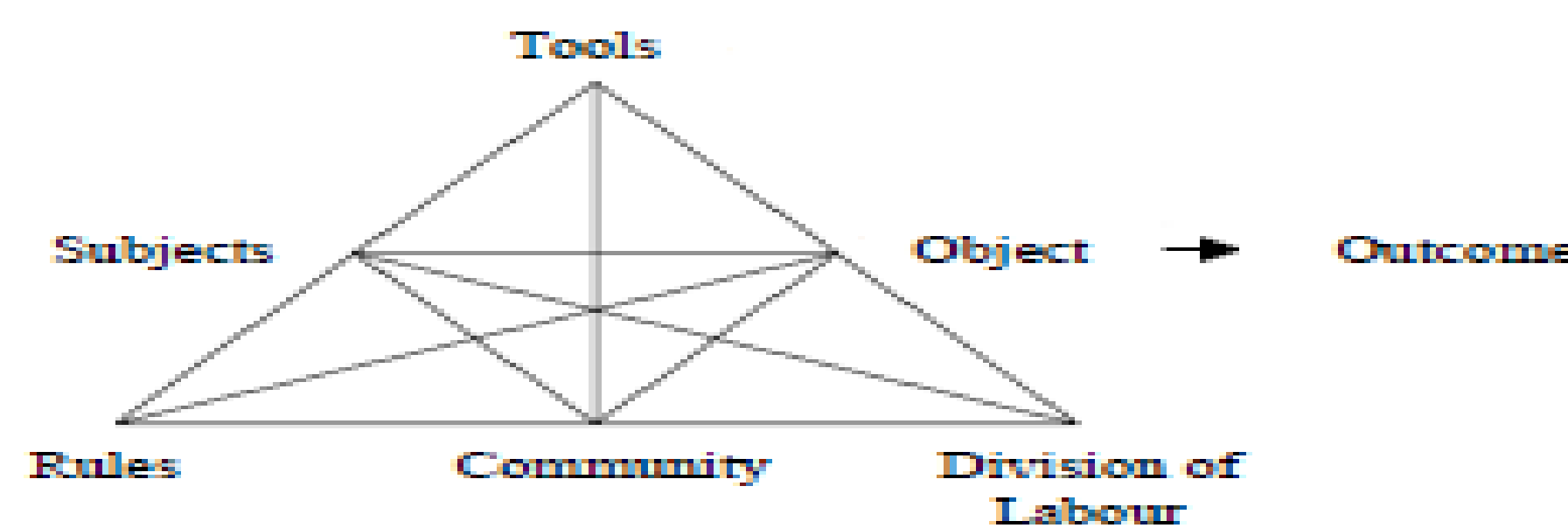## Cultural Historical Activity Theory (CHAT)

Figure 3. Engestrom representation of the activity system [4]

Contradictions are a major source of problems and ruptures in activity systems[5]. Contradictions can either enable learning to progress, or they can actually "disable" it, depending on "whether or not they are acknowledged and resolved".

TABLE 2. Engestrom's four levels of an activity system that bring about conflict for activity participants

Level 1 Primary Contradiction	When activity participants encounter more than one value systems attached to an element within an activity that brings about conflict.
Level 2 Secondary Contradiction	When activity participants encounter a new element of an activity, and the process for assimilating the new element into the activity brings about conflict.
Level 3 Tertiary Contradiction	When activity participants face conflicting situations by adopting what is believed to be a newly advanced method for achieving the object.
Level 4 Quaternary Contradiction	When activity participants encounter changes to an activity that result in creating conflicts with adjacent activities

Mediating Tools
Human: Lecturers, tutor, peers and other staff
Material tools: text books, laptops, computers
Non material tools: language, questions, and discussions

Subjects
EHP students

Objects
Achieving a good grade understanding concepts, learn enough to be a good astronomer

Rules
Admission rules
progression rules

Community
NASSP students, NASSP lecturers and Tutors

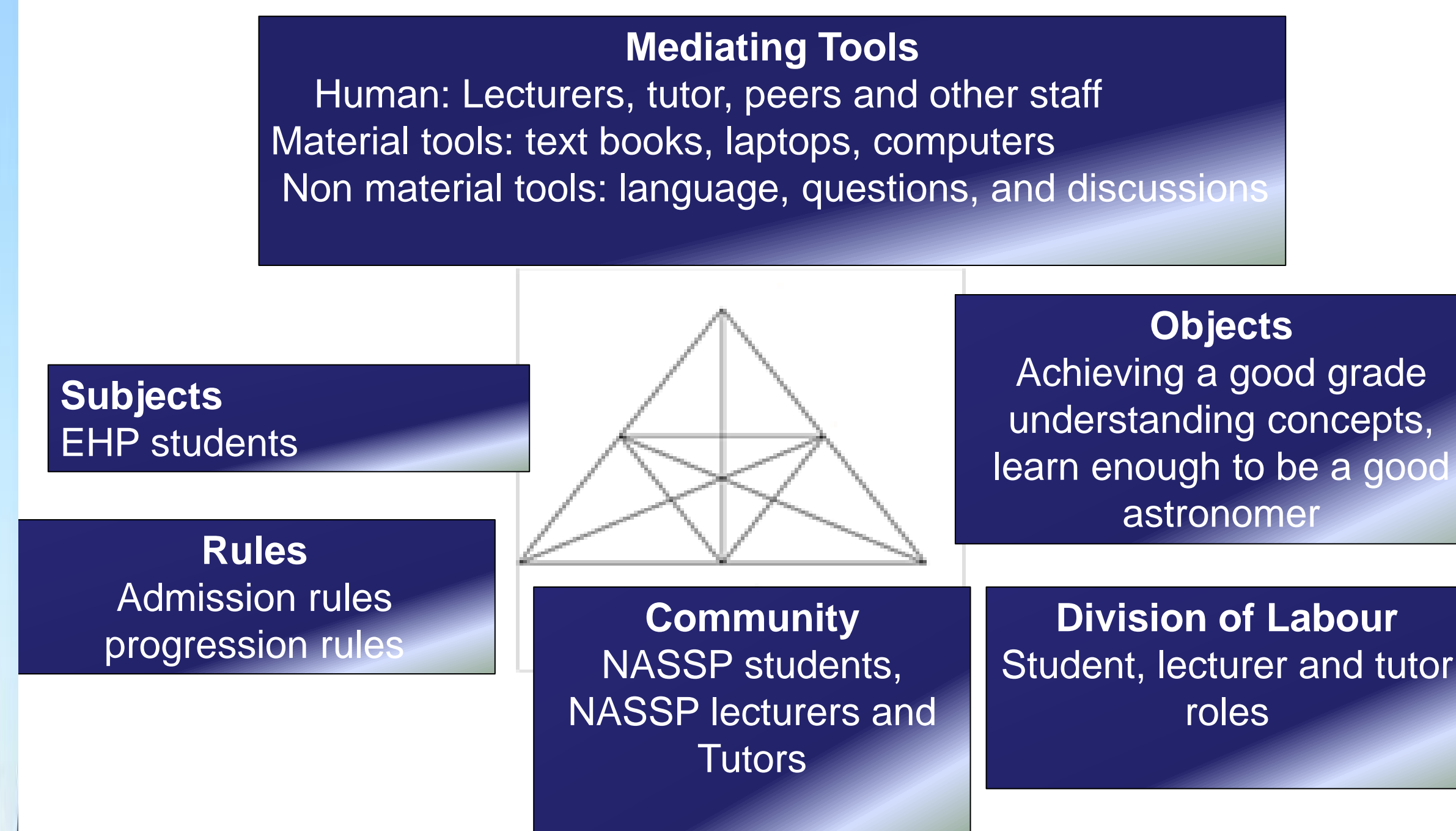**Division of Labour**
Student, lecturer and tutor roles

Figure 4. Structure of the studying (NASSP) activity system

The CHAT perspective and its principle of contradiction were useful in highlighting contradictions present in the NASSP activity system.
It also helped in understanding student's' and lecturers' experiences and more importantly highlighting areas where improvements might be necessary. It brings to the fore seemingly "invisible" practices which could be hindering progress in such a system since it targets specific components in the system such as the tools, rules, community, roles, subjects, objects and the outcome. Using CHAT as a theoretical perspective also helps to eliminate false diagnosis of causes of disturbances in systems as it employs a robust method that looks at both social and historical factors.
We also "zoomed into" a subsystem involving an intermediate level electromagnetism course to detect "micro and macro tensions. Here we identified historical and systemic tensions. These historical and systemic tensions were noted to create disturbances such as poor conceptualization of physical problems, mismatches in students and lecturers expectations and unproductive learning strategies. CHAT has provided a descriptive language to describe a complex system and to bring to the fore the multi-causal and interwoven aspects that lead to failure.

A way to "resolve" these contradictions would require buy-in from all participants in the system.

Contradictions in the system (Findings)

Primary Contradictions: Tension between Grades and Personal Sense Making.

Student: Yeah...like he had ways of solving a problem where we had to create bins and I didn't understand his method so I used my own method, it was a bit longer than his but then it worked (gigles)...you know....and like.. I could follow it step by step and understand what is going on, and then when he marked the paper, he said that... its good but then....(Shaking head) not that it is good- he marked it correct but then he said that it's a poor method. So now you are stuck with the problem of ...ok I understand this, I don't understand his method and I am going to write the exam. So if he asks me the question, what is he going to mark like...is he gonna still give me mark or is he gonna reduce because he wanted it his way, so it's like very stressful sometimes...

❑ personal understanding leads to fulfilment and understanding but it might have a catastrophic effect if it also leads to poor grade.
❑ The NASSP community values personal ownership and understanding, but the "gate keeper" is a grade which more often than not, forces students to use other strategies such as rote learning and memorization which does not aid understanding and personal ownership.

Secondary Contradictions: Tension between Students and Lecturer Status

Student: The main problem with the NASSP is that...I don't know… they were trying to take every ummmh....most of our lecturers, they were like…people with high positions…you know like (hands high in the air)…yeah. I mean you can be…youcan be in those high positions, top astronomer, but it doesn't necessarily mean that you are...you are a good lecturer or something like that…yeah…

❑ UCT is a research led university and there is a strong feeling that lecturers must be active researchers as this enhances the teaching. However students generally think it is best that teaching is done by those who are skilled educators.

Tertiary Contradictions: Adopting New Attitudes and Beliefs about Learning ("Epistemological Tensions")

Student: ok..ummh when I came here like..it's like in my mind I thought maybe we are only going to do research, I thought we are not going to attend classes, something like that you see.. that is why maybe when we are taught I always wanted to understand everything, I wanted to like, if they are teaching something, I just want to go in depth..like I don't know.. I thought maybe is..is going to be something different so on that part I was left behind, so maybe that is why I have struggled sometimes…that is where maybe I missed the point…

❑ The students imagined that learning at UCT will be very different from the styles they adopted at undergraduate at HBU's where the students usually knew what the instructor wanted and could follow a set path to achieve the object and get a good grade.

Quaternary Contradictions ("Historical disturbances")

Student: It's quite a pressure because some...sometimes you just wanna close yourself off the the family for a while and then you come back and say ok cos...like I graduated and I told them and then I told them it's fine I will be able to fund myself, but they are still stuff I still need from home, so it becomes a problem. Like.. asking for finances...and then saying...hearing them saying they are struggling its quite difficult knowing that you have a degree and you could do something to help them but you can't because you know that in order...if you go out, you still need to come back and study again in order for you to get a promotion or... stuff at work. So it becomes a …when you are dealing with family it becomes difficult.

❑ Family pressures to help family financially rather than pursue a degree in Astronomy.