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Southern African Association for Institutional Research

Data-driven decisions with Bayesian networks and data visualisation

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SAHELA 2017 Workshop
University of Pretoria & University of the Witwatersrand

Welcome

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Institutionalise Learning Analytics

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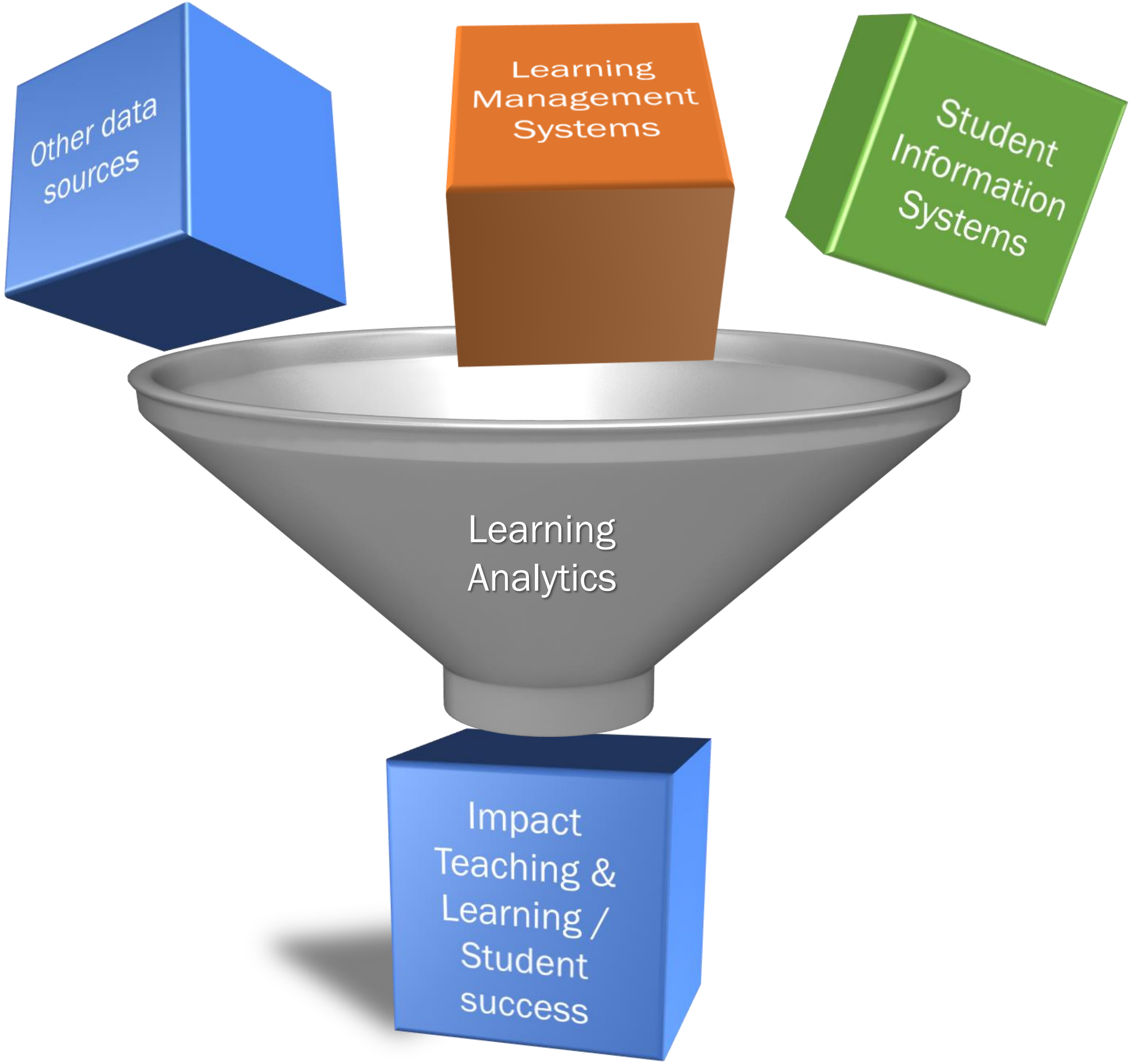


1. Other data sources and…

2. Adoption of LMS and use of clickstream data combined with…

3. Transactional- and biographical data from Student Information Systems (SIS) = drivers for LA

Allow stakeholders to identify patterns in student activity.
Challenge remains to extract value and to Institutionalise LA

(Beer *et al.*, 2012; Ferguson, 2012)

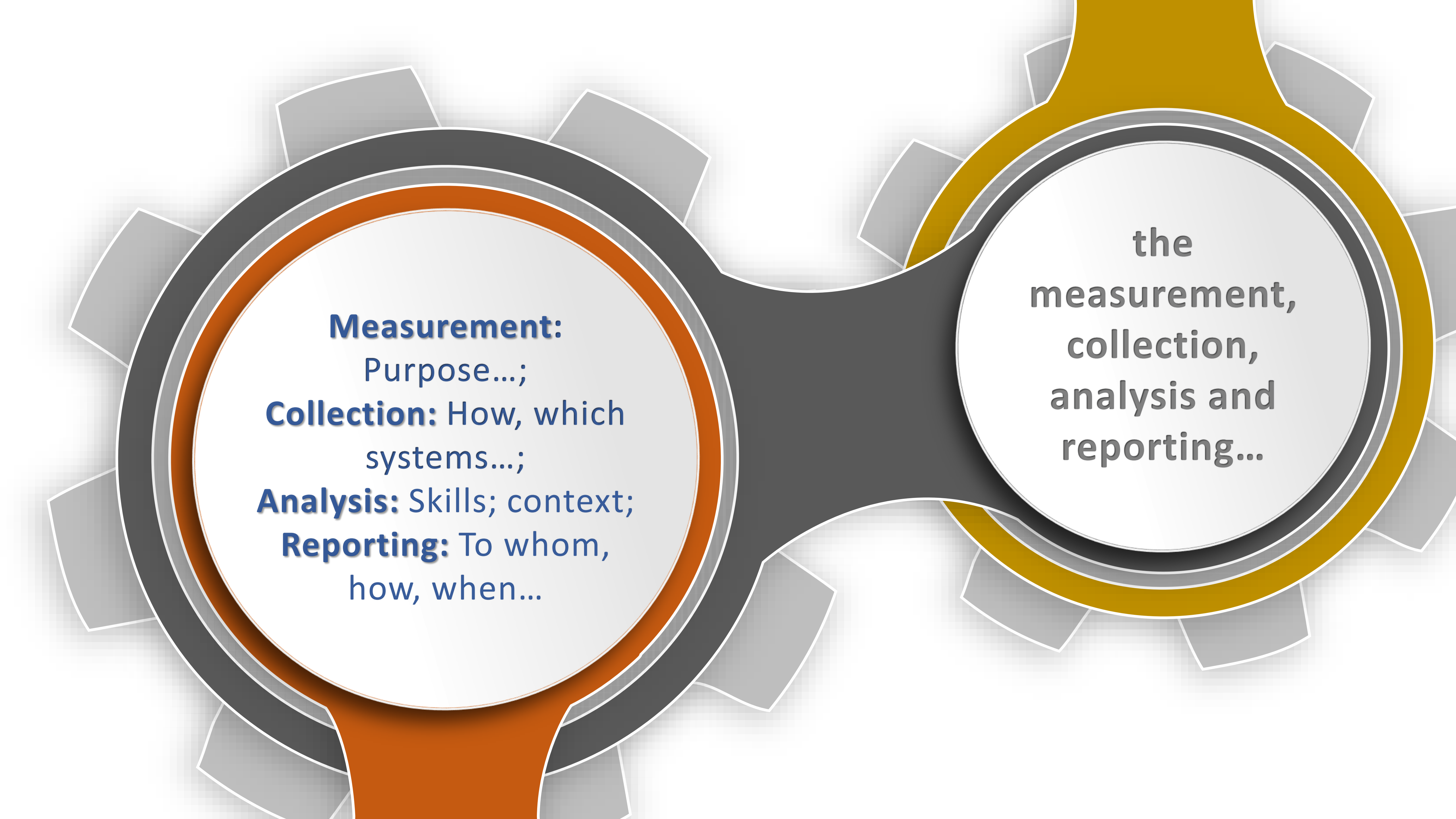
Learning Analytics Definition

“Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for the purpose of understanding and optimising learning and the environments in which it occurs.”

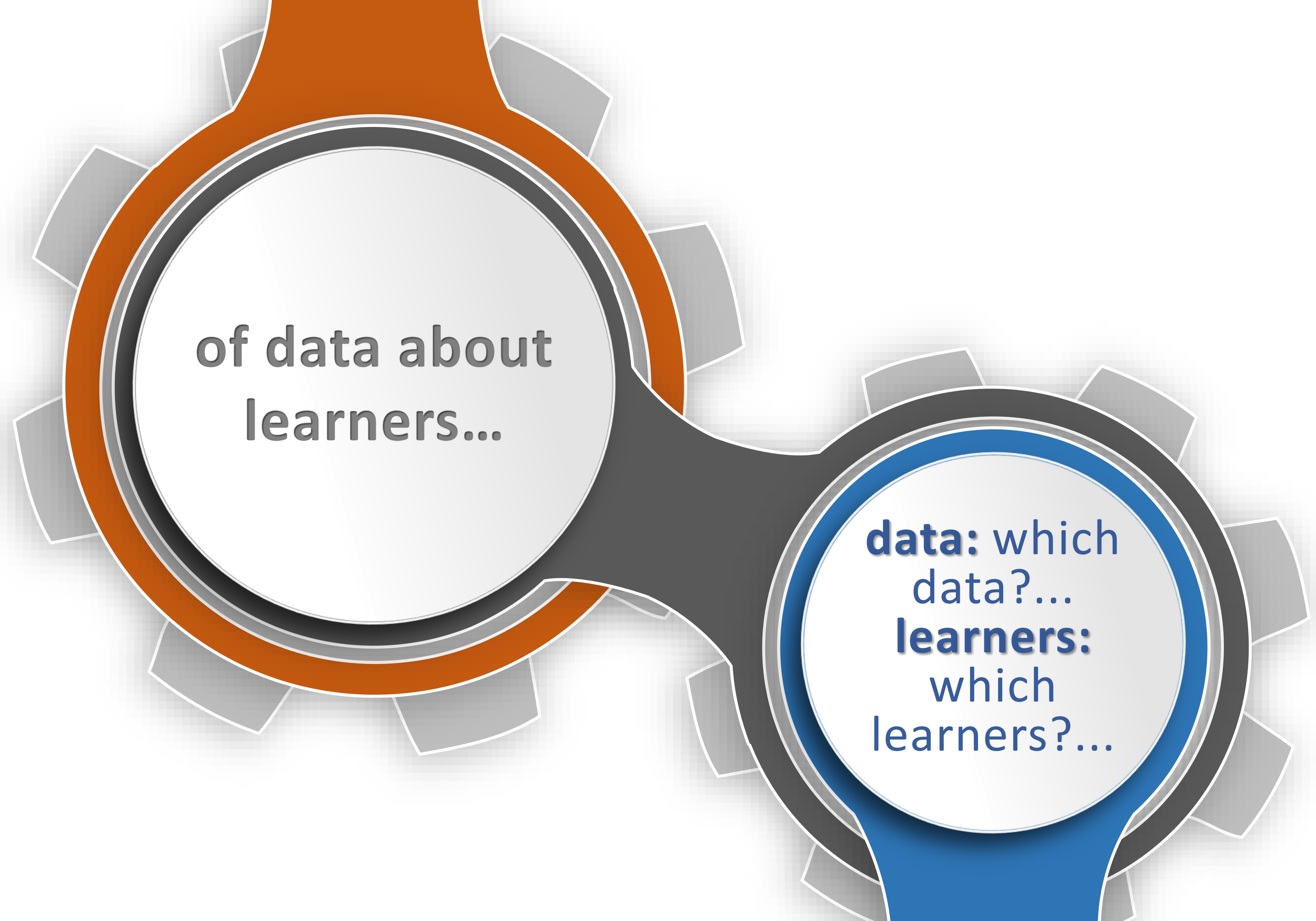
(Ferguson, 2012,Siemens and Long, 2011)

Learning Analytics is…

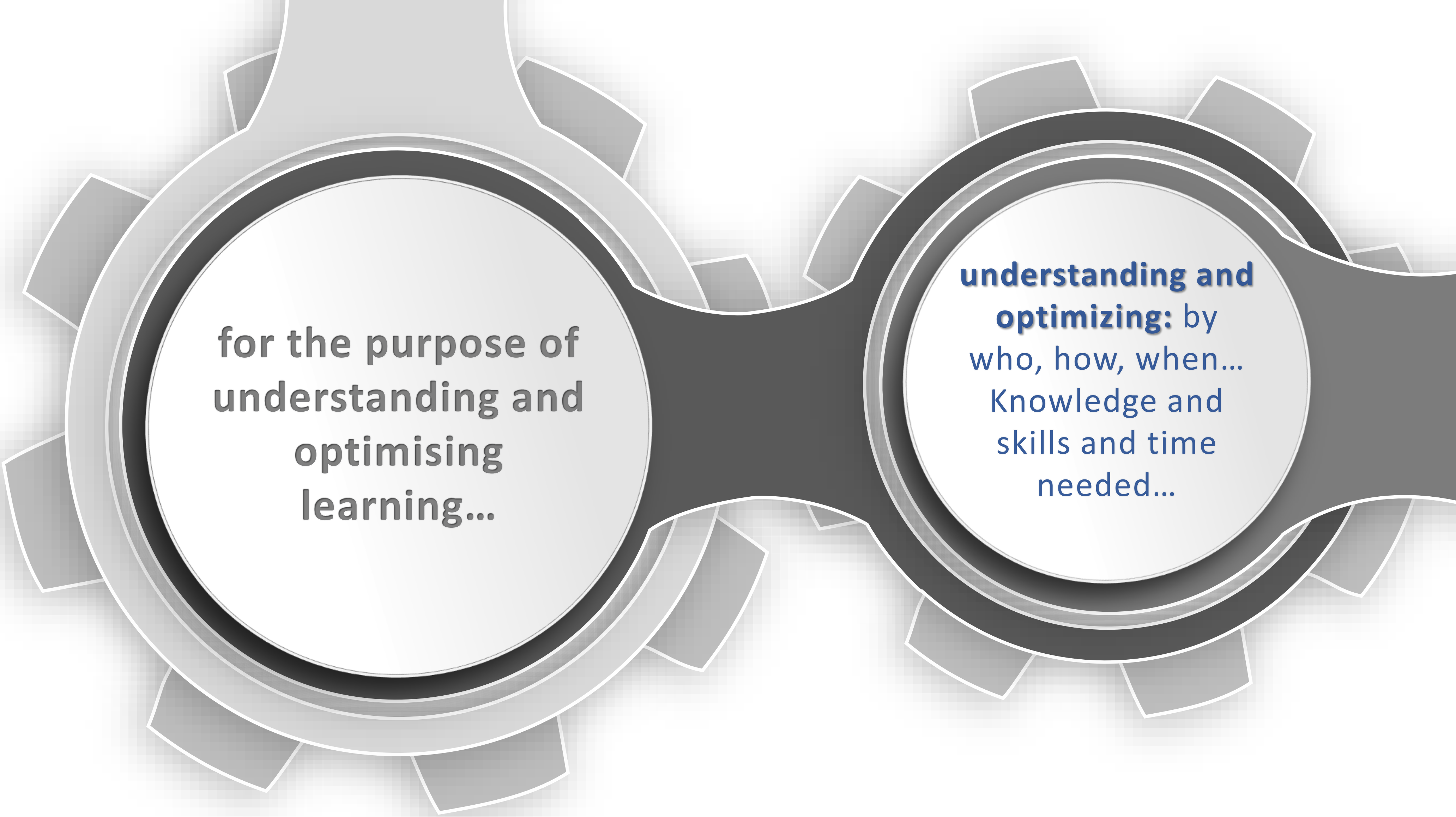
Learning or learner?



Measurement: Purpose…;
Collection: How, which systems…;
Analysis: Skills; context;
Reporting: To whom, how, when…
the measurement, collection, analysis and reporting…


of data about learners...
data: which data?...
learners: which learners?...


and their contexts…
Context: which context, what must be included or excluded…



(Dietz-Uhler and Hurn, 2013)

and the environments in which it occurs.

environments: Online, Face-to-face, off-campus…
in which it occurs: real time, measurement of changes, willingness…

Large Scale Adoption

Challenges

Case studies

Adoption models

Dimension

Challenges

Summary of challenges documented and experrienced

Case studies

Examples of successful institutional adoption

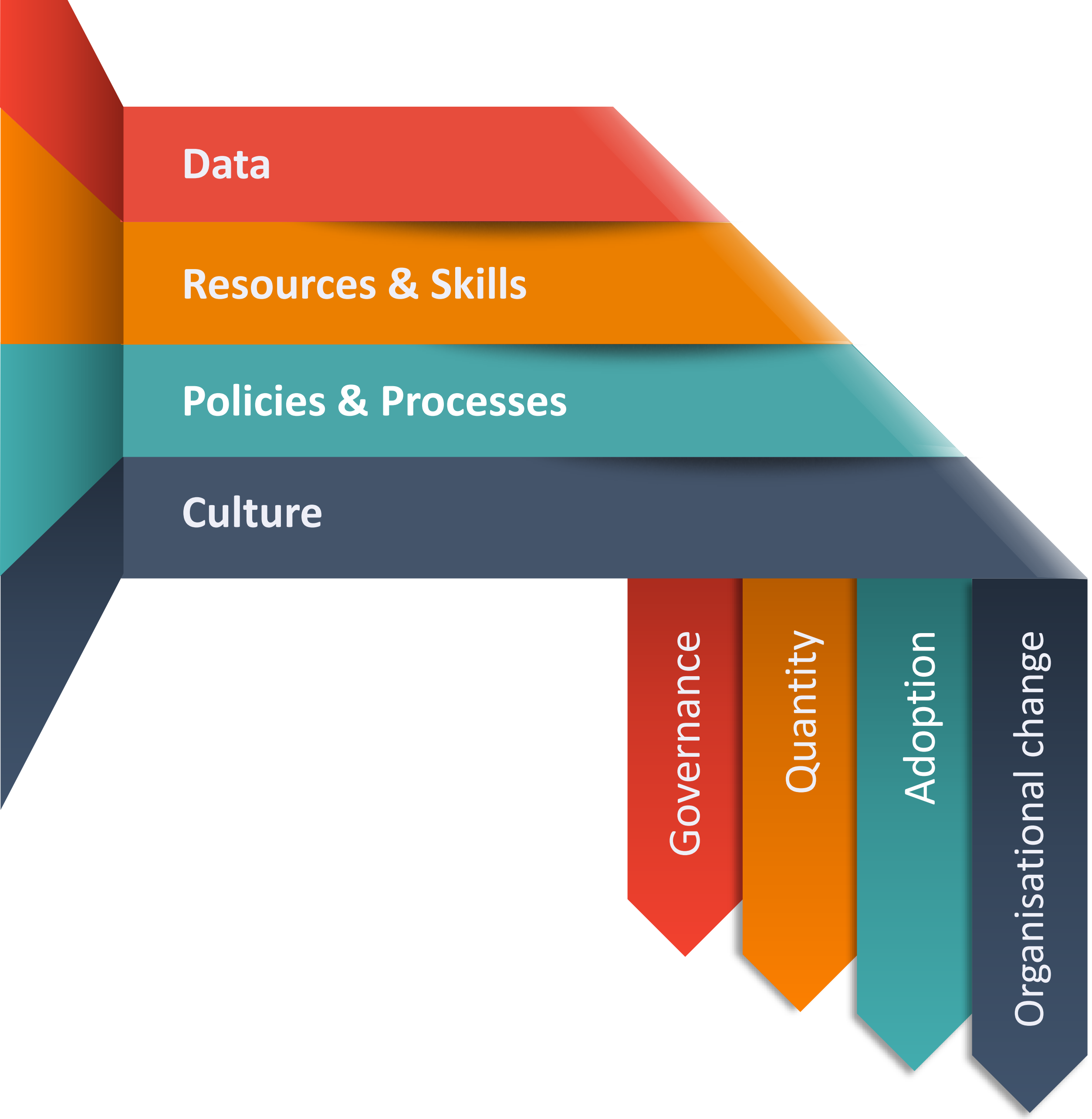
Models

Overview of existing institutional adoption models for LA implementation

Capacity

Evaluating a single adoption capacity area

Challenges



Data

Management, access, standardisation, interpretation, access, accuracy…

Resources & Skills

Access to HR, IT & Financial resources to sustain LA; new skill set. Stakeholders…

Policy & Process

Adoption of new & evaluation of related policies. Institutional processes

Culture

Resistance to change, Institutional priorities, Evidence of data-driven decision making

Click Mouse to Advance Animation

Large Scale Adoption: Case Studies

Purdue Signals

Pioneering work at the University of Purdue through the Course Signals systems (Arnold and Pistilli, 2012)

Nottingham Trent University

Providing students, tutors and support staff access to a student progress dashboard using data from various data sets (Day, 2015;Foster, 2015)

Maryland, Baltimore County

Student facing notification dashboard which allowed students to 'Check my Activity" (Fritz, 2011)

Open University UK

Experience in managing student data supported throug considerable research informed the institutional adoption of evidence based decision-making (Ferguso

Purdue Signals

It uses descriptive data from the SIS, LMS and gradebook to provide a student facing report with an interface simulating a traffic light

Nottingham Trent University

Student dashboard at NTU received positive feedback from tutors and students and resulted in an institutional culture of data-driven decision making.

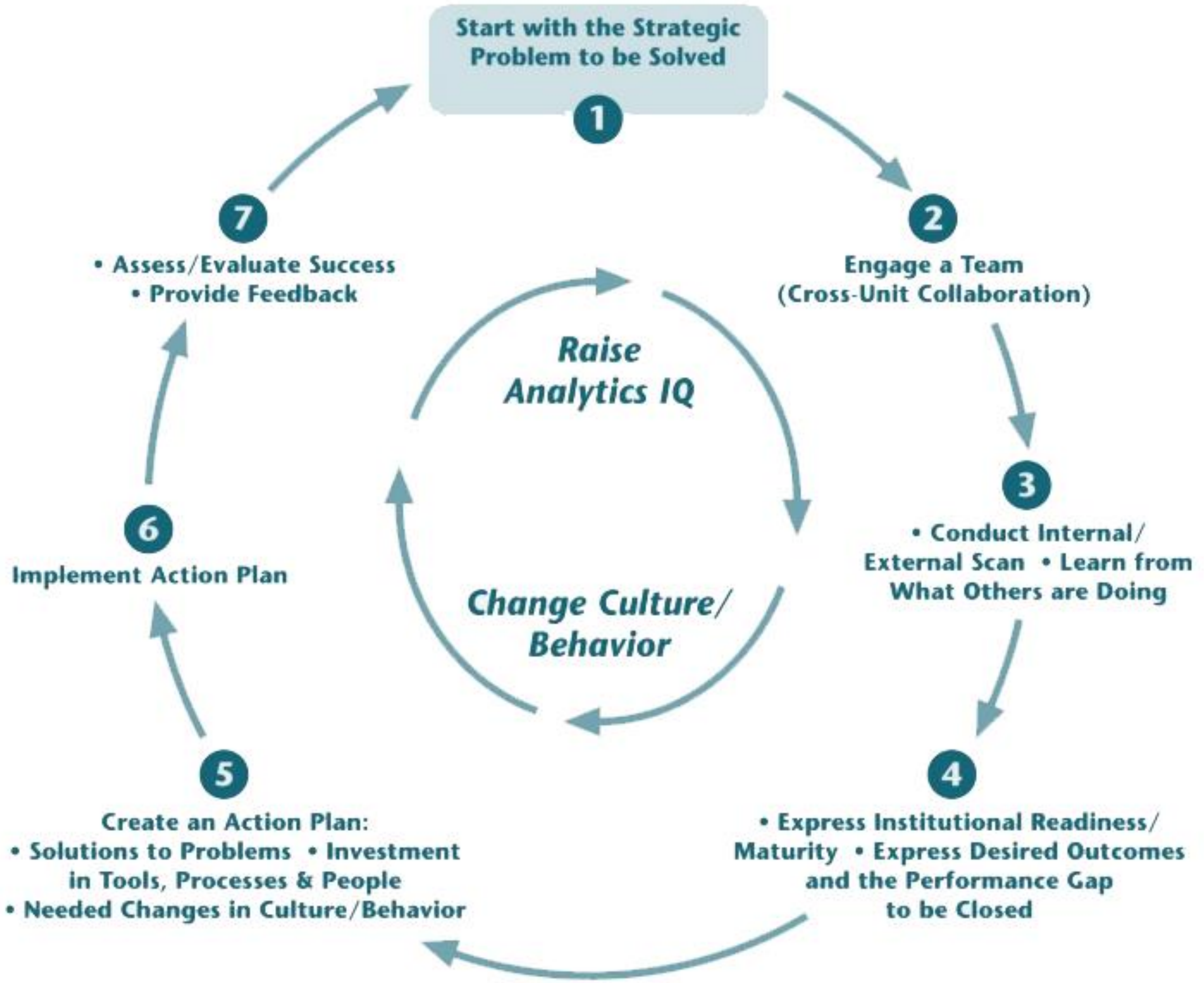
Maryland, Baltimore County

Provides students with real-time feedback about their own performance to enhance student responsibility for learning.

Open University UK

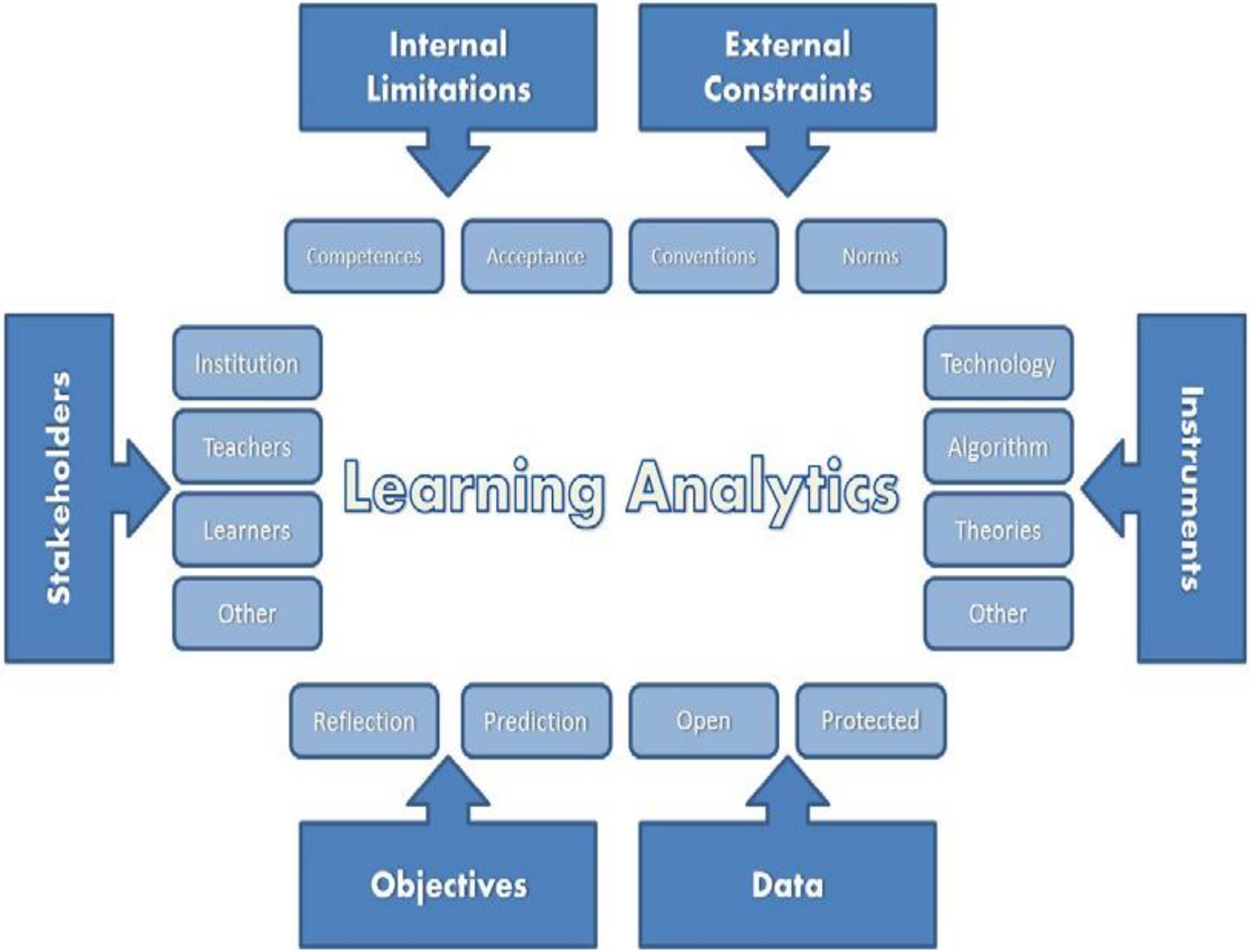
Senior management act as sponsor for the project and provided the vision and took ownership for implementation of the ROMA Framework to institutionalise learning analytics

Action Plan for Analytics



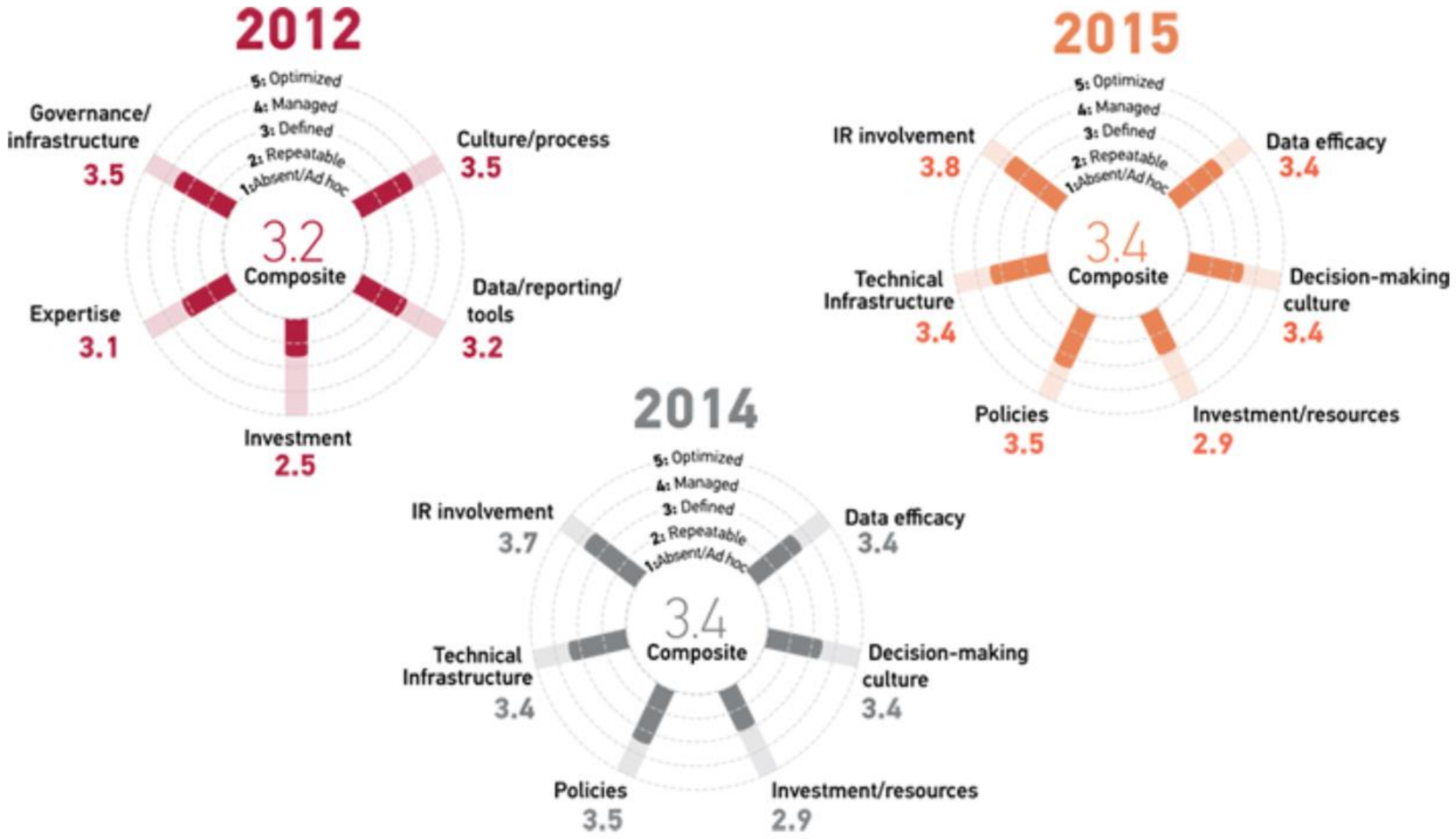
(Norris and Baer, 2013)

Greller & Drachsler



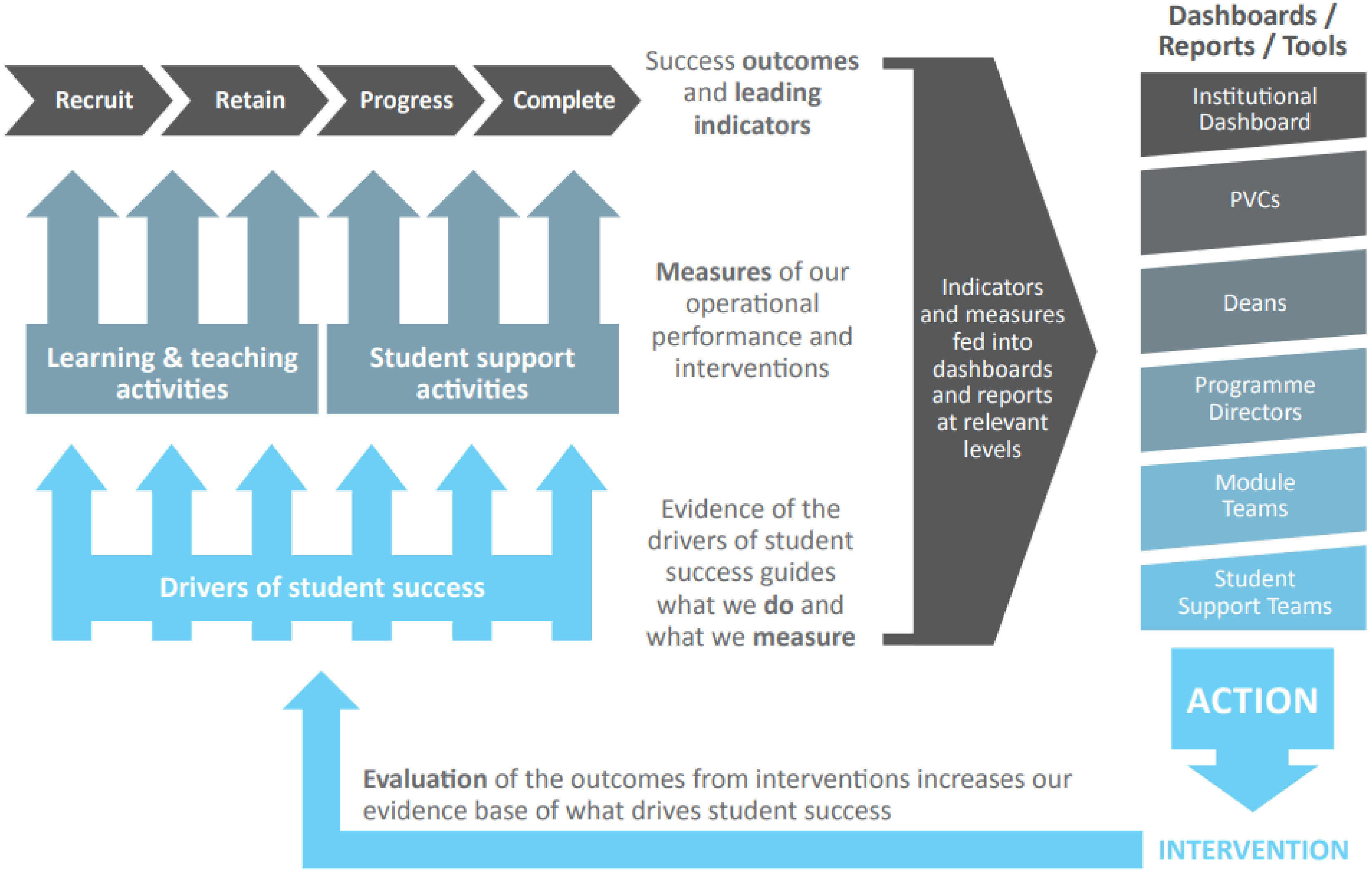
(Greller and Drachsler, 2012)

EDUCAUSE: LA Maturity index



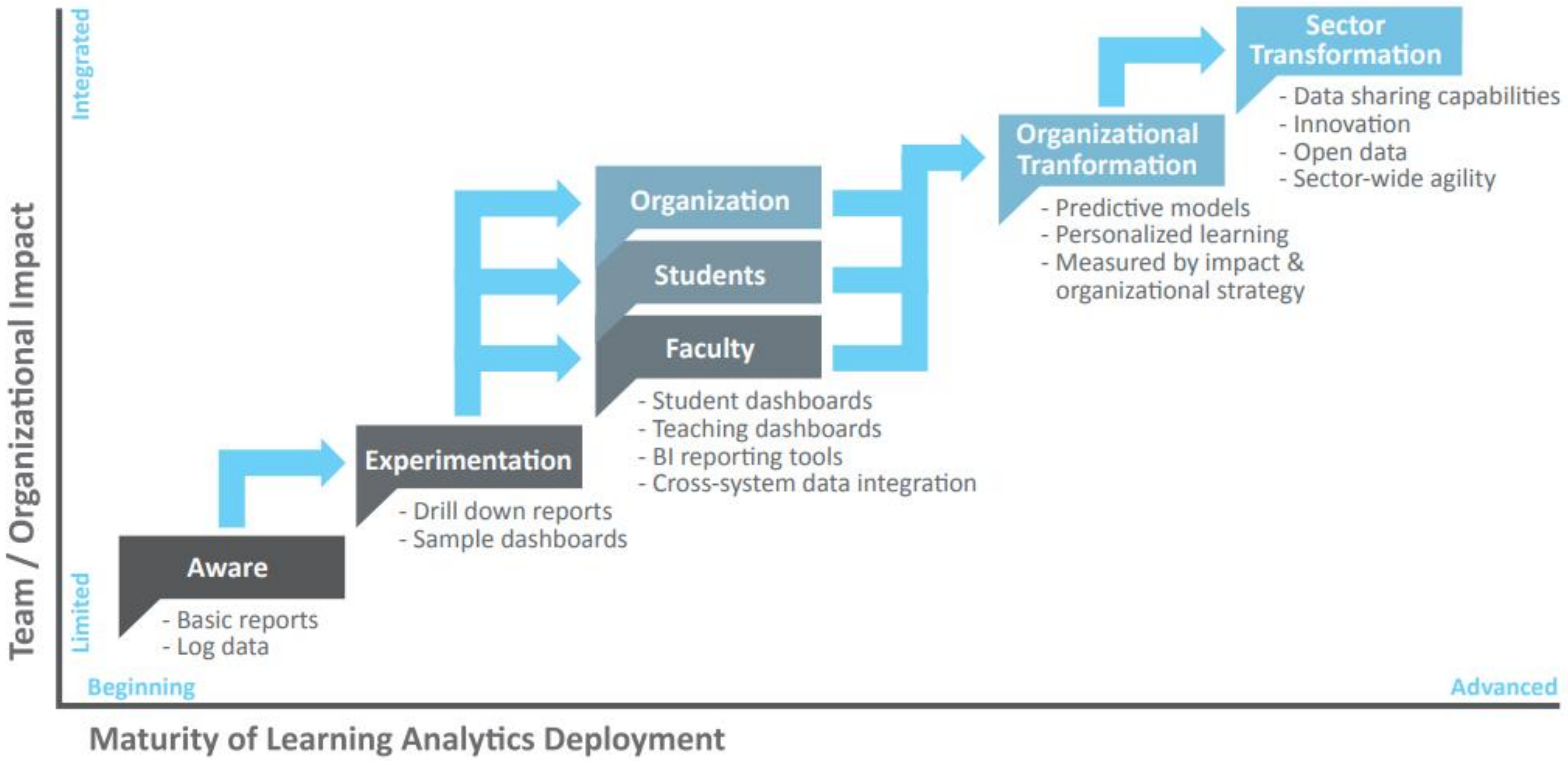
(Dahlstrom, 2016)

Systemic LA at the OU in the UK



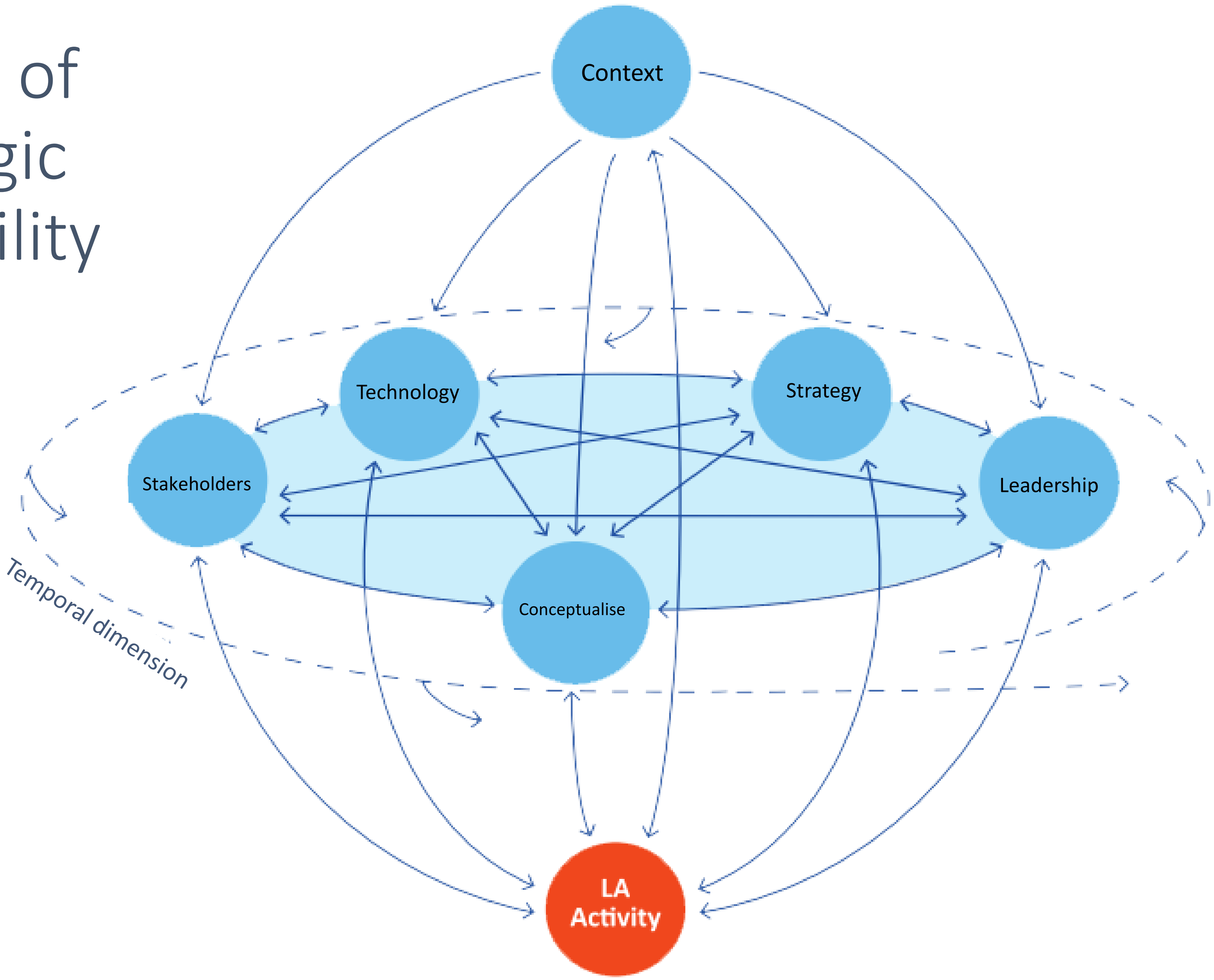
(Tynan & Buckingham Shum, 2013 as quoted in Siemens *et al.*, 2013)

LA Sophistication Model



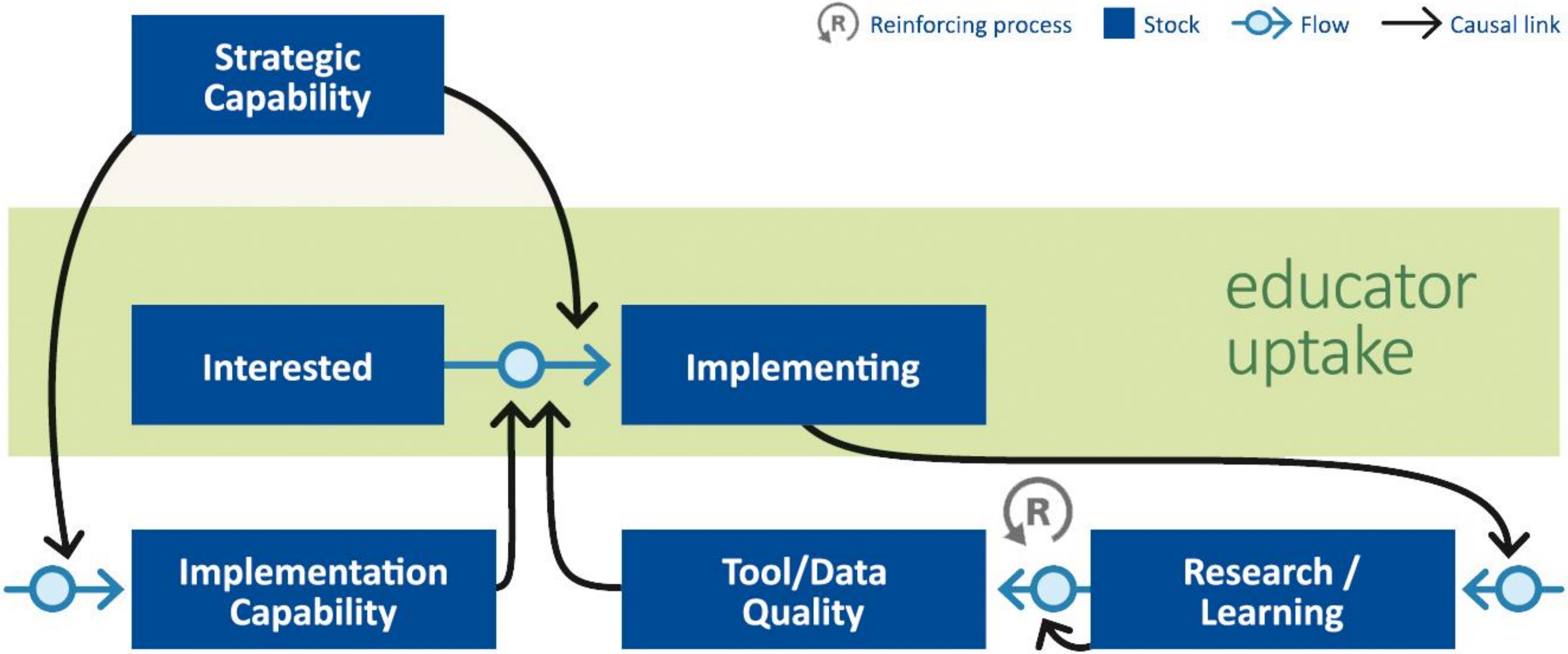
(Siemens *et al.*, 2013)

Model of Strategic Capability



(Colvin *et al.*, 2015)

Model of system conditions for sustainable uptake of LA



(Colvin *et al.*, 2015)

Learning Analytics Drivers

Institutional	Name of Institution
Retention	
Course level performance	
Demonstrate effectiveness in T&L	
Understand student characteristics	
Improve course design / quality	
Improve service delivery	
Faculty productivity	
Reduce costs	
Cohort analysis	
Other	

Mapping of institutional adoption capacity areas

LARI (Arnold, Lonn & Pistilli)	EDUCAUSE: Maturity Index 2015	Jisc
Culture & Processes	IR involvement	Culture & Vision
Data management expertise	Technical infrastructure	Ethics & Legal issues
Data Analysis Expertise	Policies	Strategy & Investment
Governance / Infrastructure	Investment / resources	Structure & |Governance
Readiness perception	Decision-making culture	Technology & Data
	Data efficacy	
?	?	?

Capacity activity

List

- List the critical institutional adoption dimensions

Indicate

- Indicate institutional stakeholders involved and their role / needs

Evaluate

- Evaluate existing- and required skills and resources

State

- State impact the dimension may have on student success interventions

Plan

- Plan action steps in order of feasibility and priority

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THANK YOU !

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Educational Technology
and ICT trends

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Bayesian logic and Data visualisation

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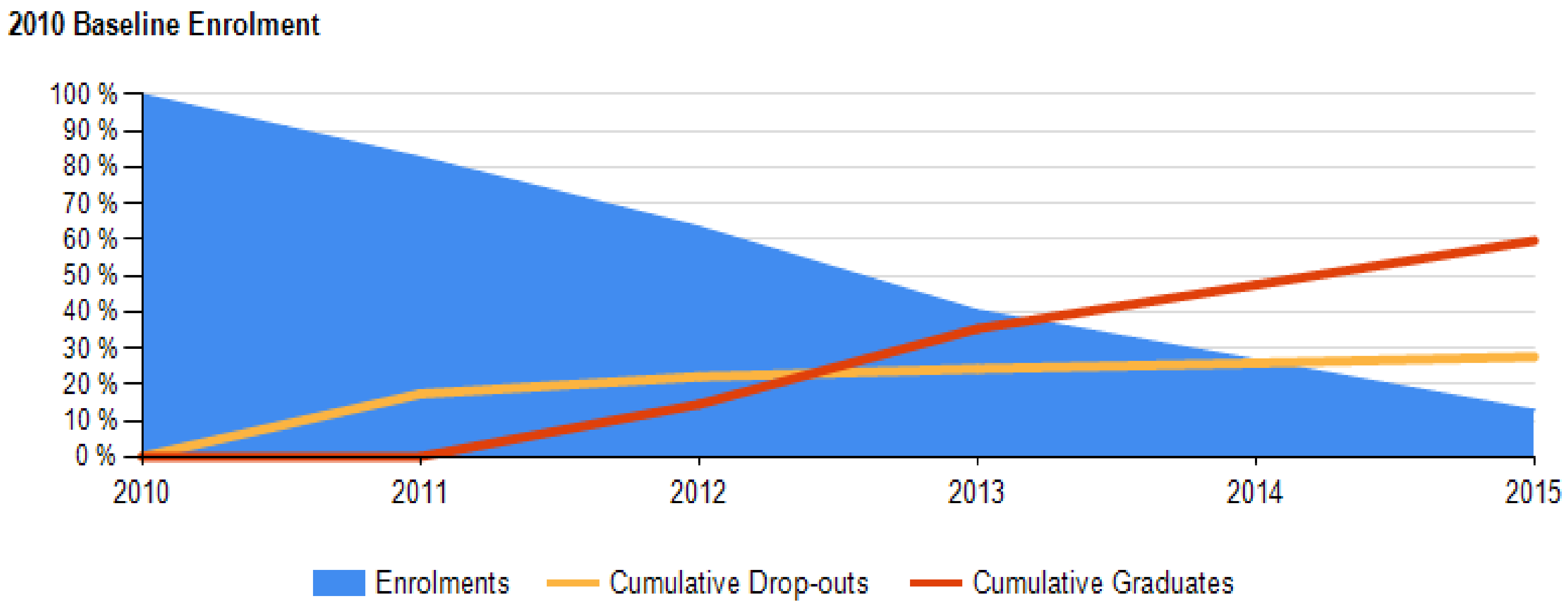
Objectives

- Analyse student throughput
- Answer questions such as
  - % students completing studies in
    - min time
    - min + 1 time
    - min + 2 time
  - % students still active in system
  - Per faculty
  - Demographics

Descriptive Statistics

- Heda System



Alternative Approach

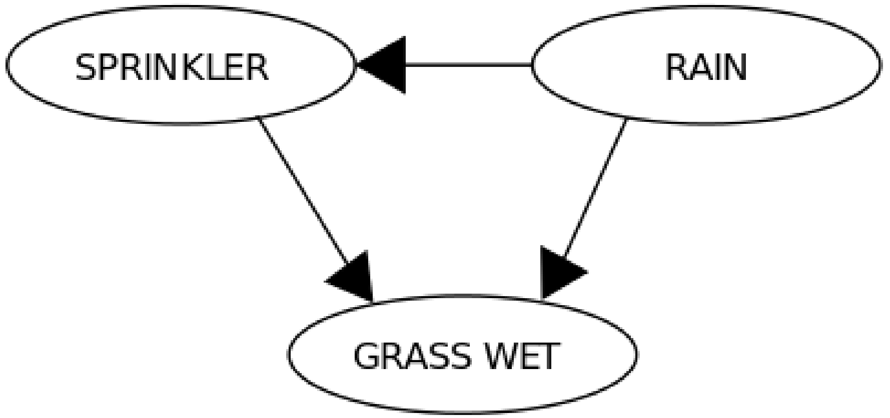
- Knowledge base system (KBS)
  - Knowledge base - contains information about the system
  - Inference engine - contains logical rules about the system
- Main output
  - Reason about the system

Bayesian networks

- Graphical structure
  - Nodes
    - A set of random variables
  - Directed Arcs
    - Connect nodes, representing the direct dependencies between variables
    - Strength of dependencies is quantified by conditional probability distributions associated with each node.

Example

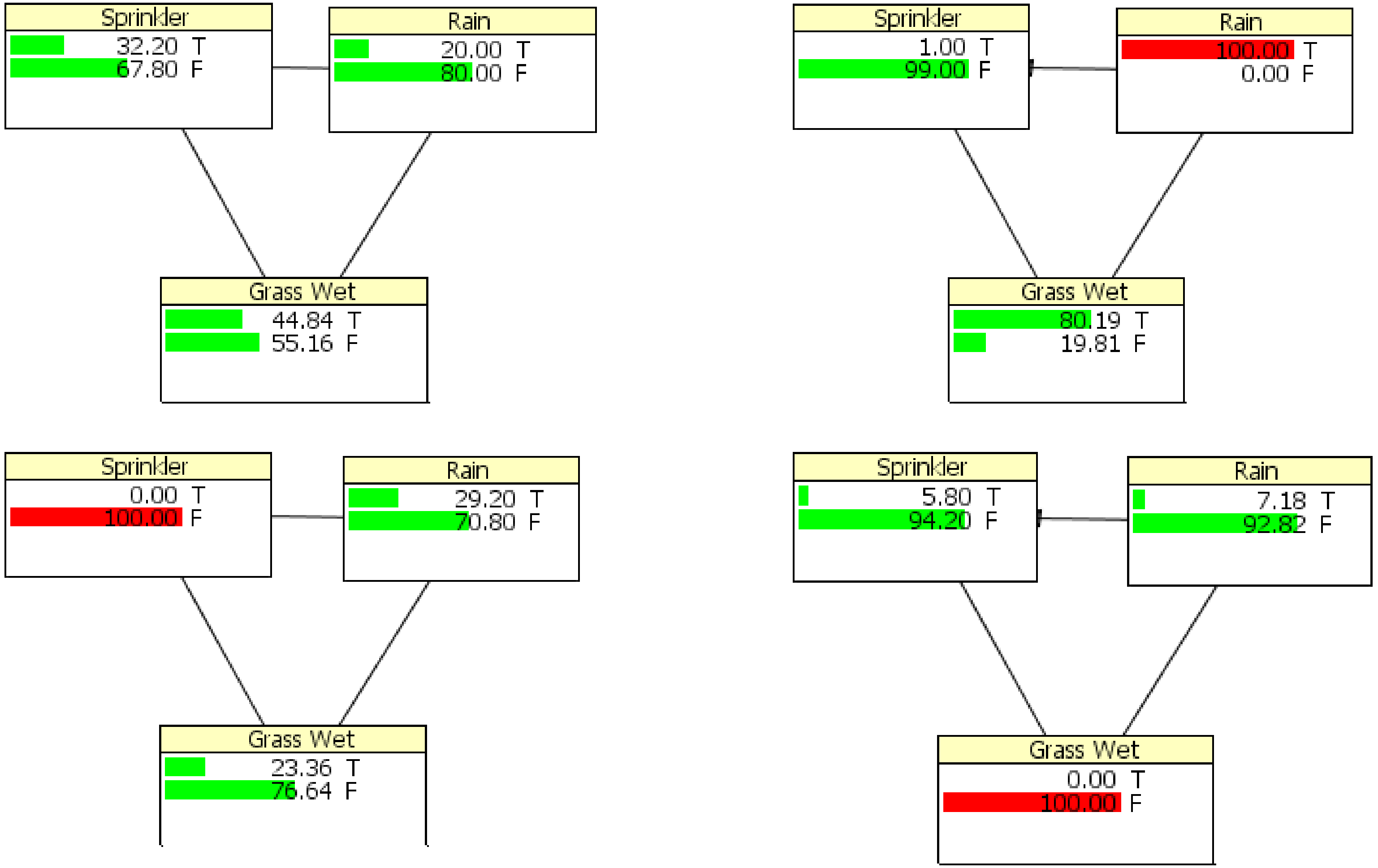
	SPRINKLER	
RAIN	T	F
F	0.4	0.6
T	0.01	0.99



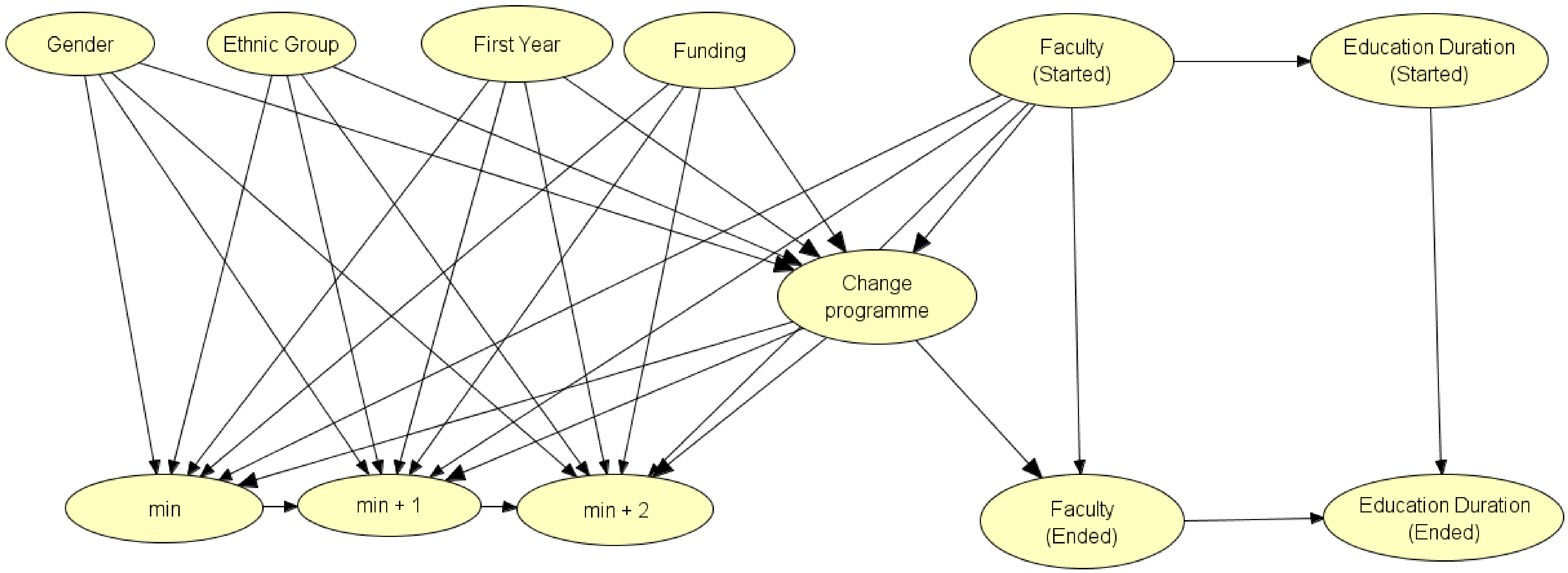
RAIN	
T	F
0.2	0.8

		GRASS WET	
SPRINKLER	RAIN	T	F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01

Inference (What-if Analysis)

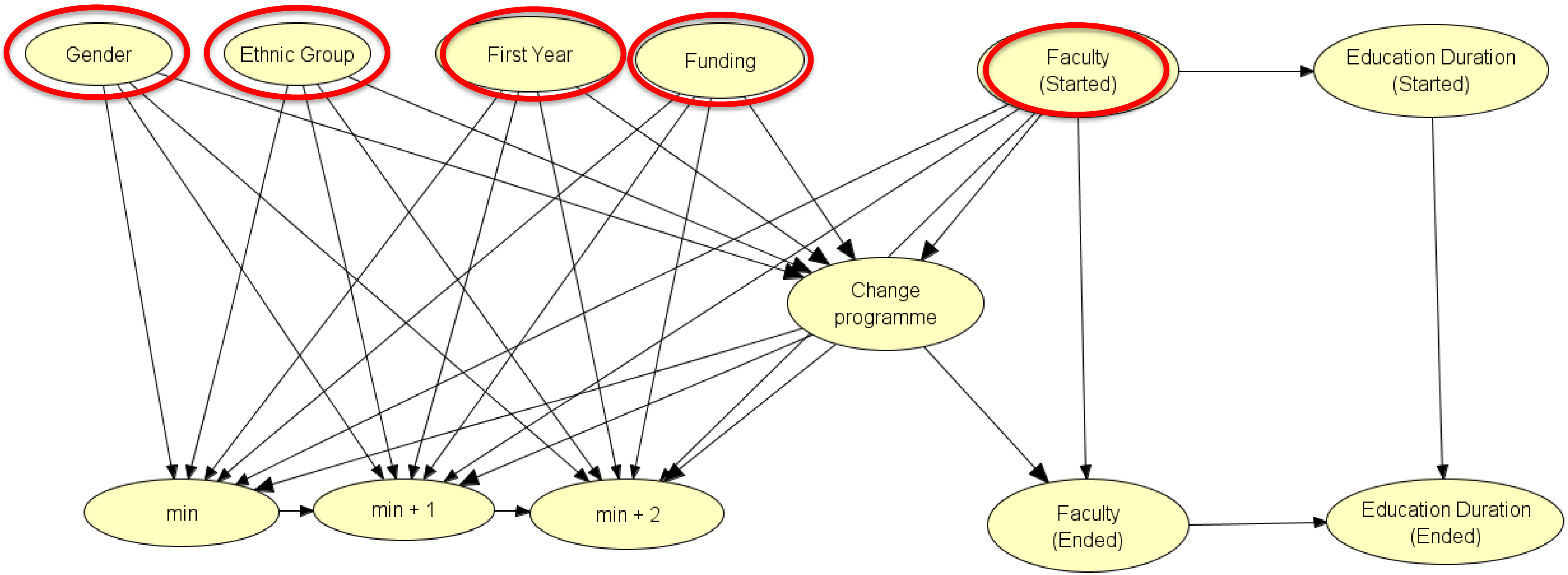


Leitlho*
A KBS for Student Throughput Analysis

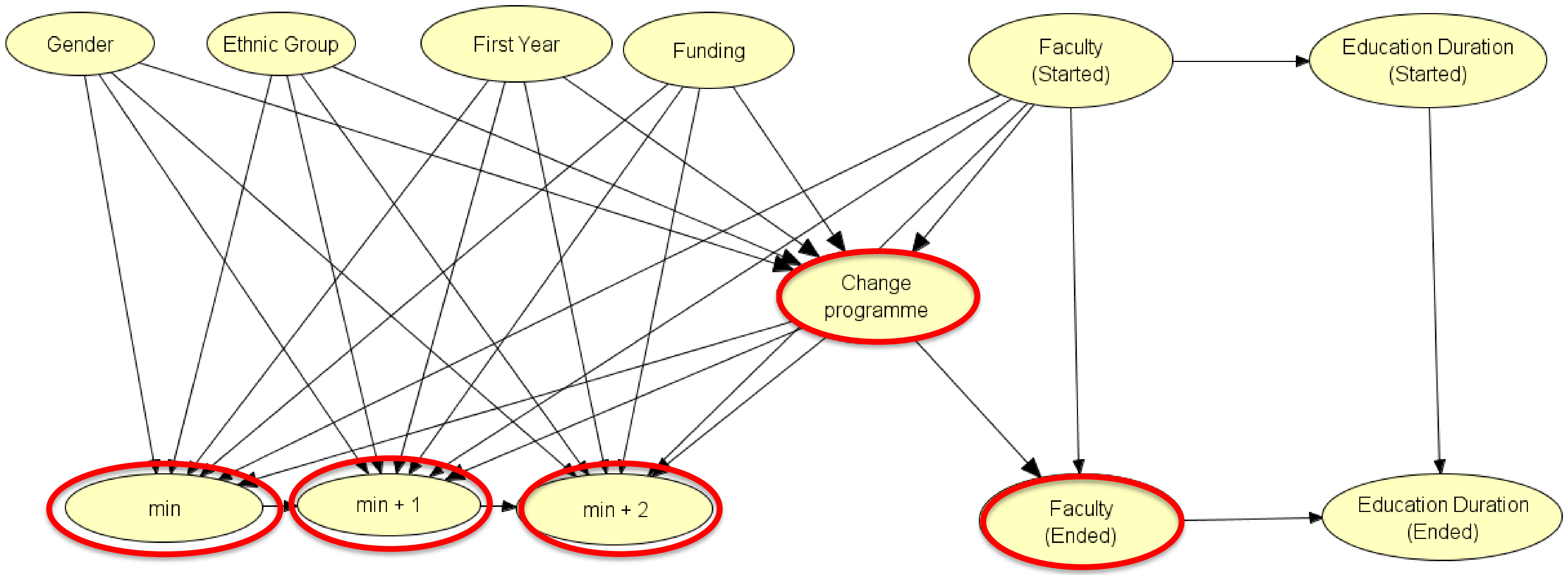


*Leitlho means 'eye' in Setswana

“Independent” Variables

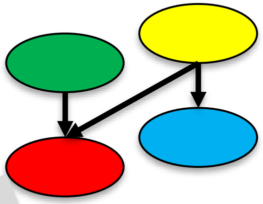


“Dependent” Variables

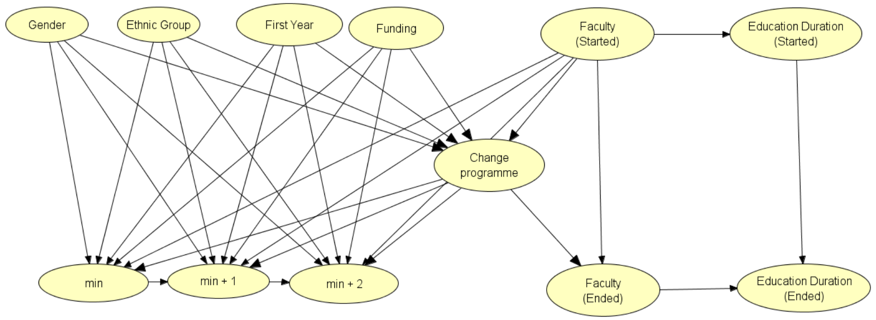


Components of model

- Data
  - Preprocessing (Python)
  - One line per student (csv format)
- Graphical structure
  - Variables
  - States of variables
  - Structure
- Parameterise
  - EM Algorithm



EM Algorithm
(Parameterise)



The Wits Biographic Questionnaire

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The Wits Biographic Questionnaire

- Comprehensive school and student background questionnaire, administered to first-time, first year students
- Aimed at better understanding how a student’s background influences theirs success the University
- Using the BQ, the University will be in a better position to implement appropriate programmes that support the high school/ university transition

The Biographic Questionnaire

- The Biographic Questionnaire is currently funded by the Kresge Foundation (Siyaphumelela 'We Succeed' Project)
- One of the main objectives of the Wits Siyaphumelela Project is to 'Understand university readiness among undergraduate students'

BQ Progress

- The student Biographic Questionnaire is fully online and has been integrated into the Wits administration process (compulsory)
- Data collected in 2016 & 2017

BQ Structure

- **Home background**
  - *Facilities at home; Location; 1st Generation status; Family support structure; Financial income; Educational background, etc.*
- **School background**
  - *Location; Classification; Infrastructure; Language of instruction; etc.*
- **Additional Information**
  - *Payment of tuition fees; Part-time employment; Accommodation; How far is student stay from campus; Mode of transport, etc.*

BQ- Role players

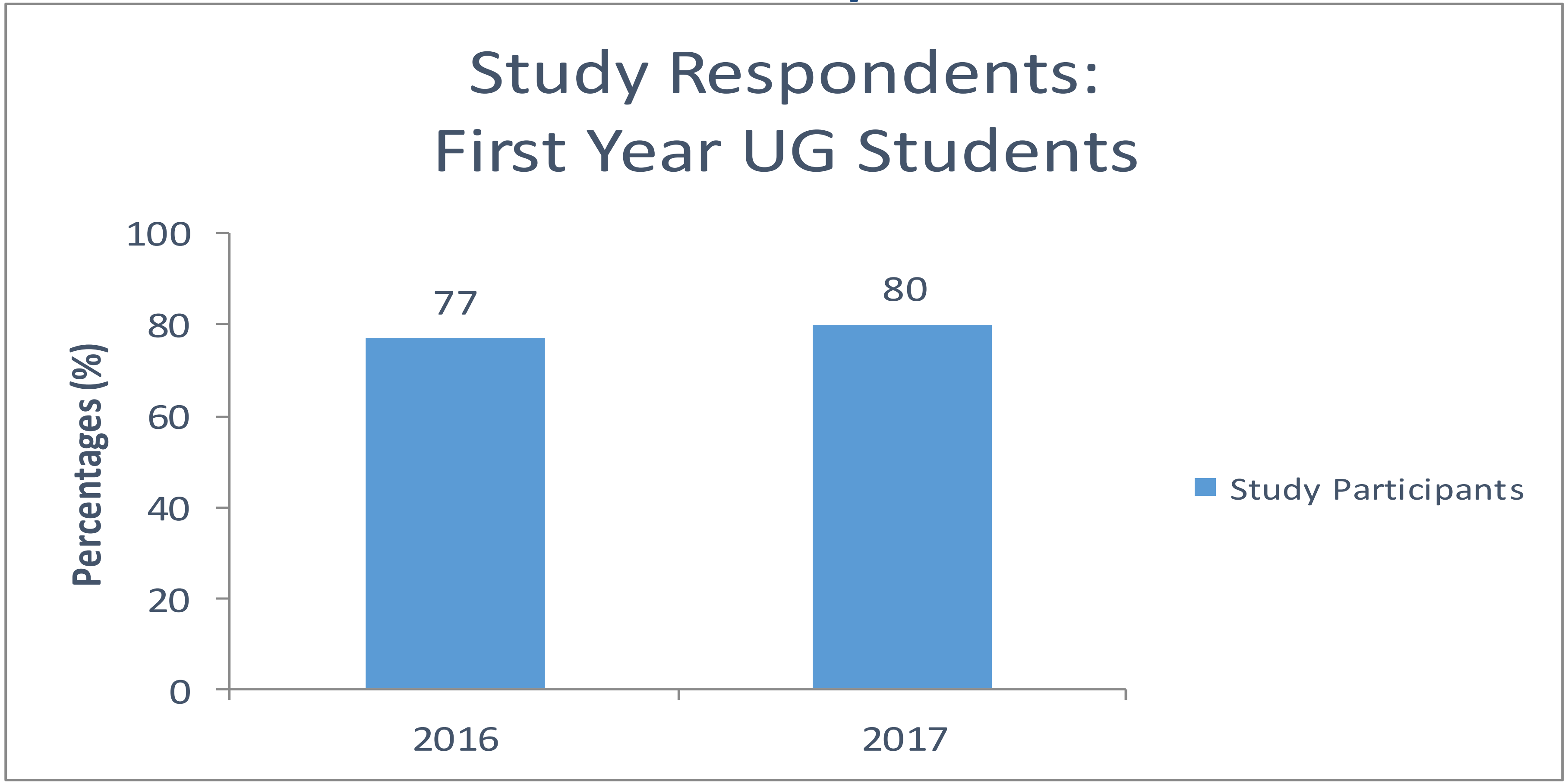
1. Support from the Registrar and DVC Academic
2. Independent developer and the Wits Academic Information Systems Unit (AISU)
3. First year experience (FYE) office
4. Wits call center
5. Wits student enrolment center
6. Faculty Program coordinators

BQ Coordination

- BQ planning takes place during the last quarter of the year
  - Reviewing questionnaire
  - Initial meeting with role-players

- January
  - Training to temp call center agents and FYE student assistants
  - Reminders sent to role-players
  - Weekly progress emails during course of registration

BQ Response rate



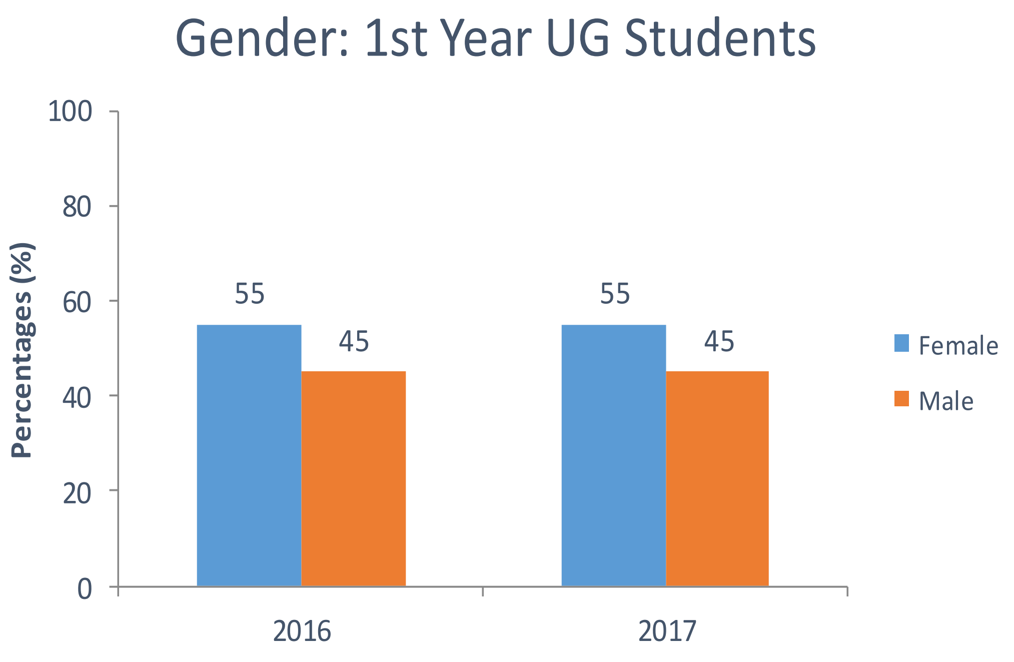
- Why not 100%?

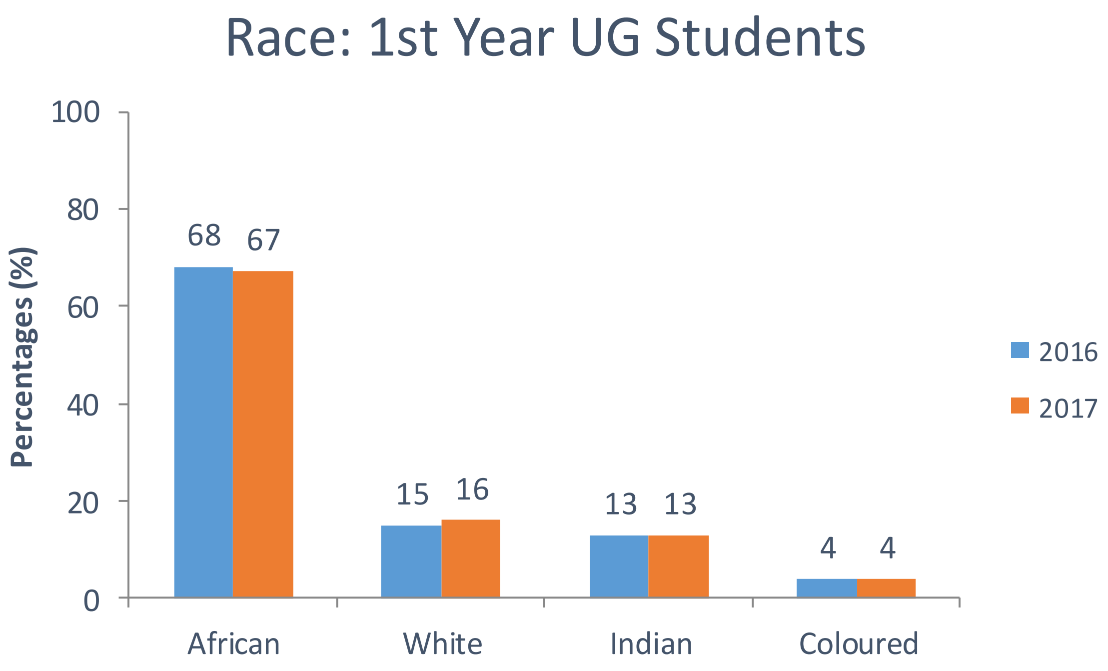
BQ Challenges

- Mostly technical in nature
  - Students ‘not seeing’ the BQ
  - Internet browser version
  - Reminder emails
  - Tracking progress
- Computer proficiency not a challenge

BQ Results 2016/2017

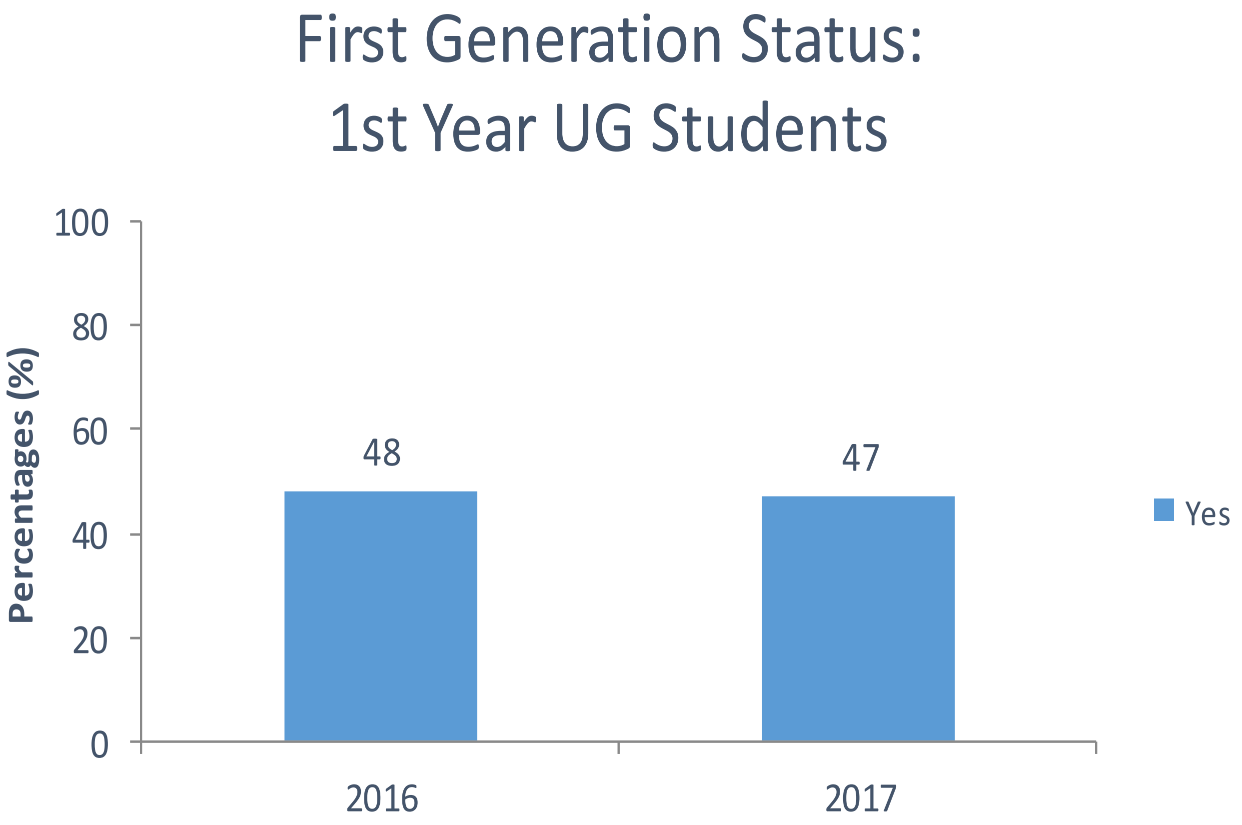
- Gender and Race (from University data)





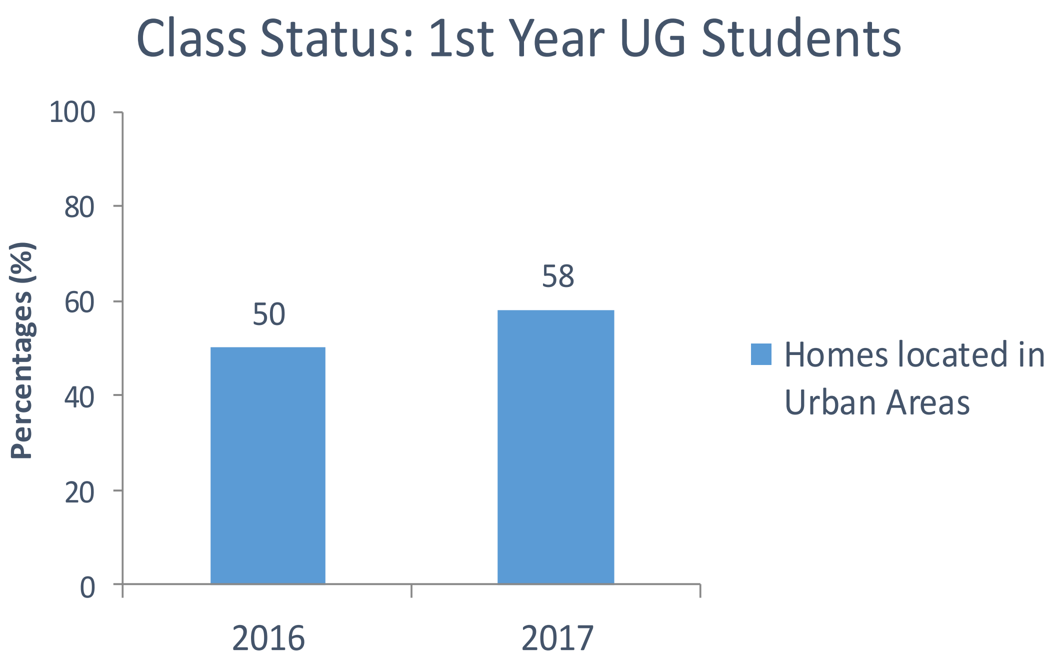
BQ Results 2016/2017

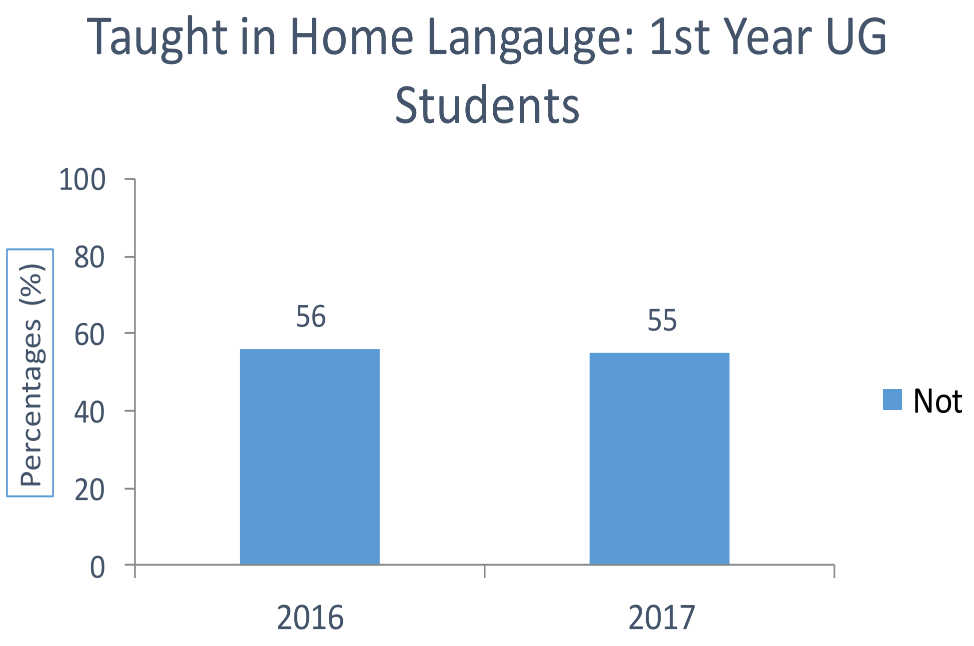
- First generation status



BQ Results 2016/2017

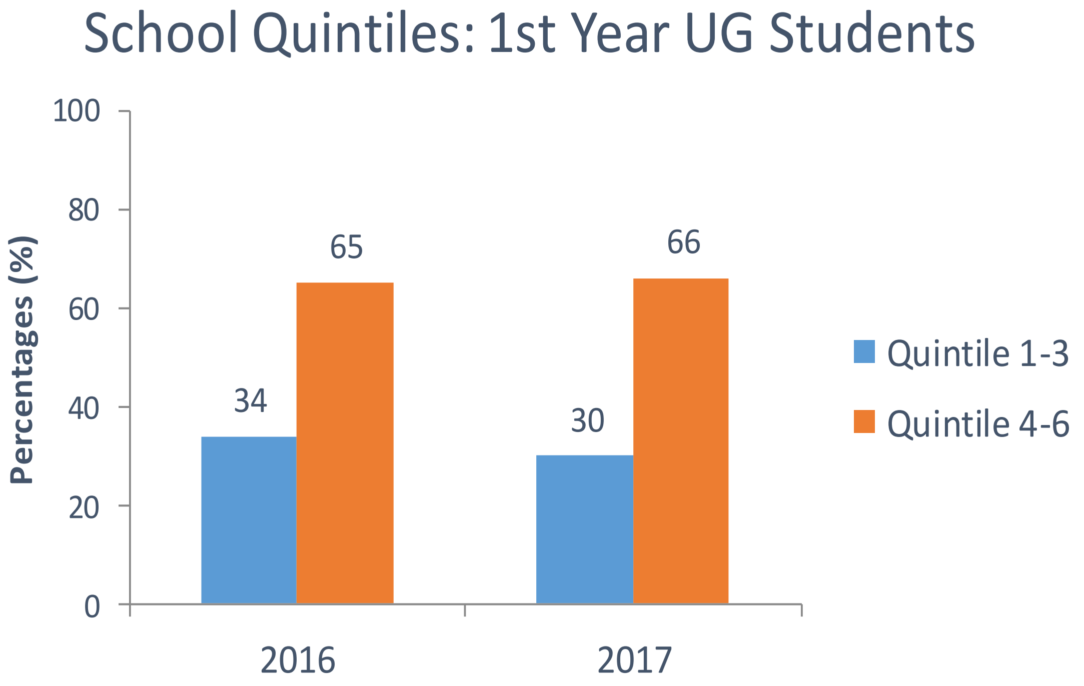
- Home information

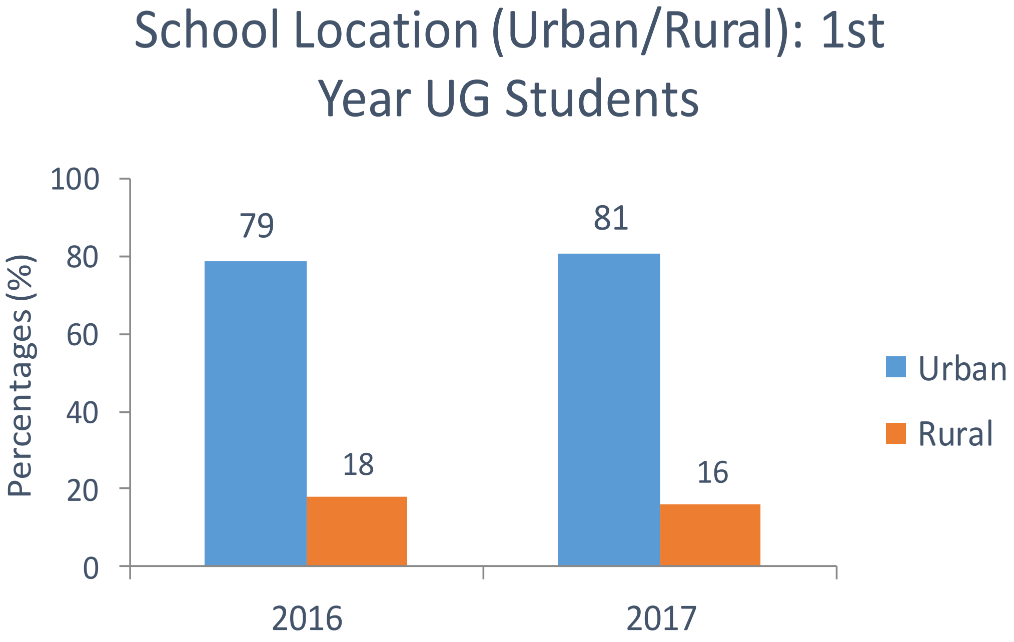




BQ Results 2016/2017

- School information





BQ Results 2016/2017

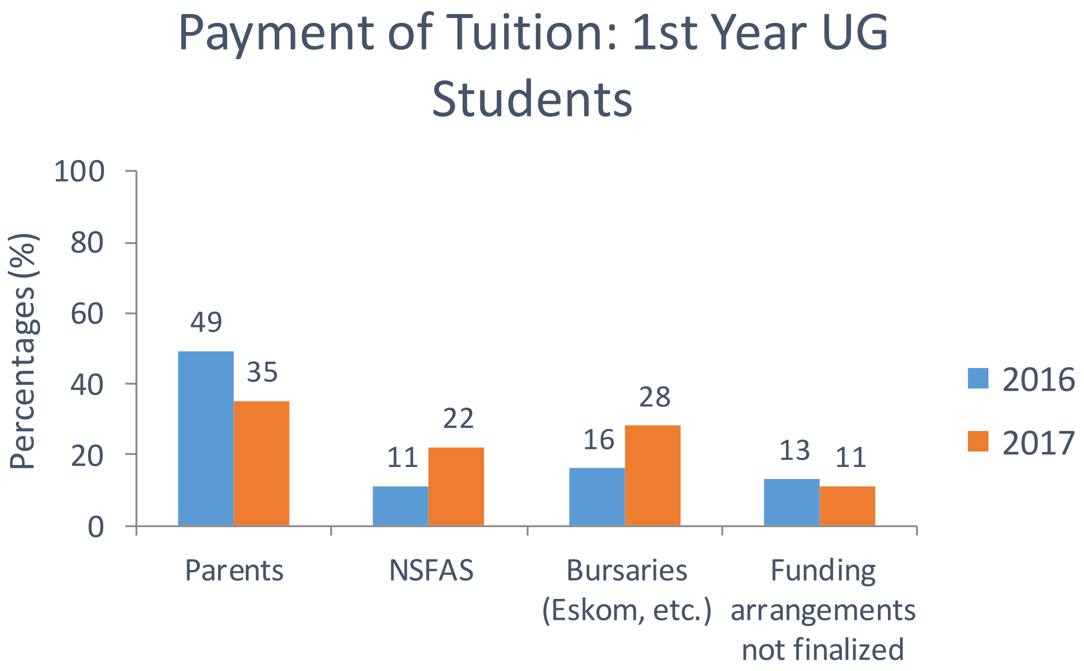
- School information

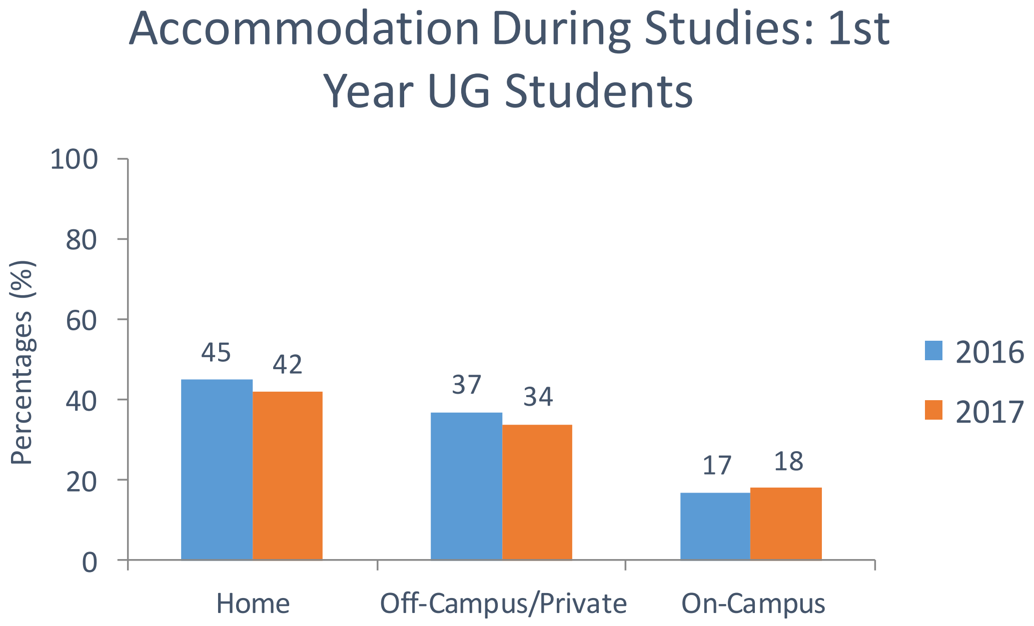
School Infrastructure:

	2016	**2017**
Science Labs	77% (65%)	75% (66%)
Library	68% (58%)	70% (59%)
Computers	78% (62%)	78% (61%)

BQ Results 2016/2017

- Tuition and accommodation





BQ Reporting

- Preliminary data analysis February
- Present prelim data to University Forum late March
- Data triangulation/ validation April/ May
- Final report June

The BQ moving forward

- Data collection will continue in 2018
- Partner with other Universities
- Conducting analysis looking at student performance
- Longitudinal potential
  - following progress of student cohorts over time

Thank You

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The case of Wits: Discussion

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Presentation on Bayesian models (The case of UP and Wits)

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Student throughput analysis using a Bayesian Model : The case of UP

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Roadmap

- Main objective
- Research questions
- Model
- Results
  - Institutional level (UP)
- Impact

Main objective and research questions

- Main objective
  - To analyse student throughput using a Bayesian Model
- Research questions
  - From which Faculty/Gender/Ethnicity students graduate in minimum time?
  - Which demographic profiling of students are more likely to be active after minimum graduation time plus 2 years?
  - Does funding have an impact on the profiling of UP students?
  - Are students who change programmes more likely to dropout?
  - What variables are most likely to impact on students academic performance?

Processed variables

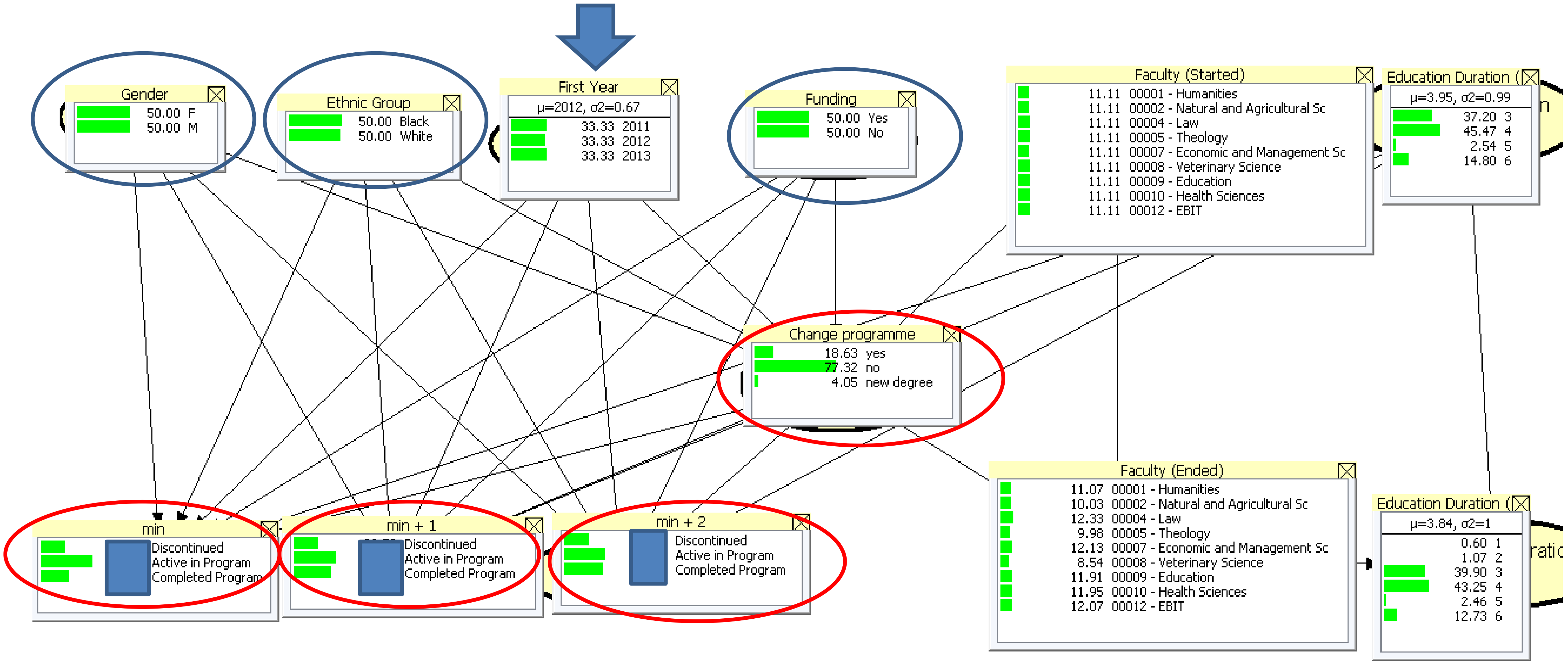
Independent variables

- Gender: Gender description of the student.
- Ethnic group: Ethnic group of the Students according to Hemis.
- First year: First term of the student at the institution (2011,2012, and 2013 Cohort).
- Funding : Yes/No , the status indicate whether a student has a sponsor such as a bursary, loan etc.

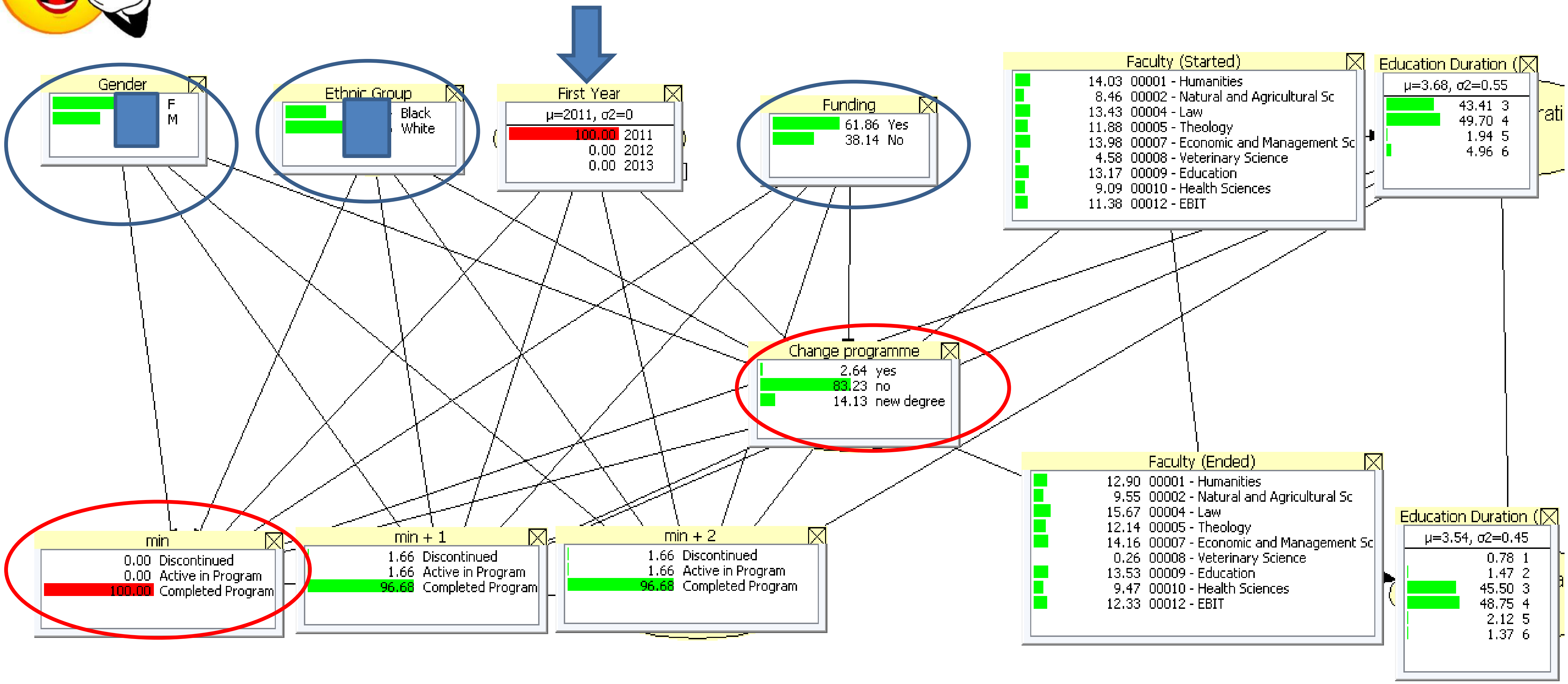
Dependent variables

- Change study programmes?: Yes/No
- Min: the minimum number of years of study required for the completion of the qualification.
- Min + 1: the minimum number of years of study required for the completion of the qualification plus 1 year.
- Min + 2: the minimum number of years of study required for the completion of the qualification plus 2 years.

Model (Institutional Level): Student throughput analysis

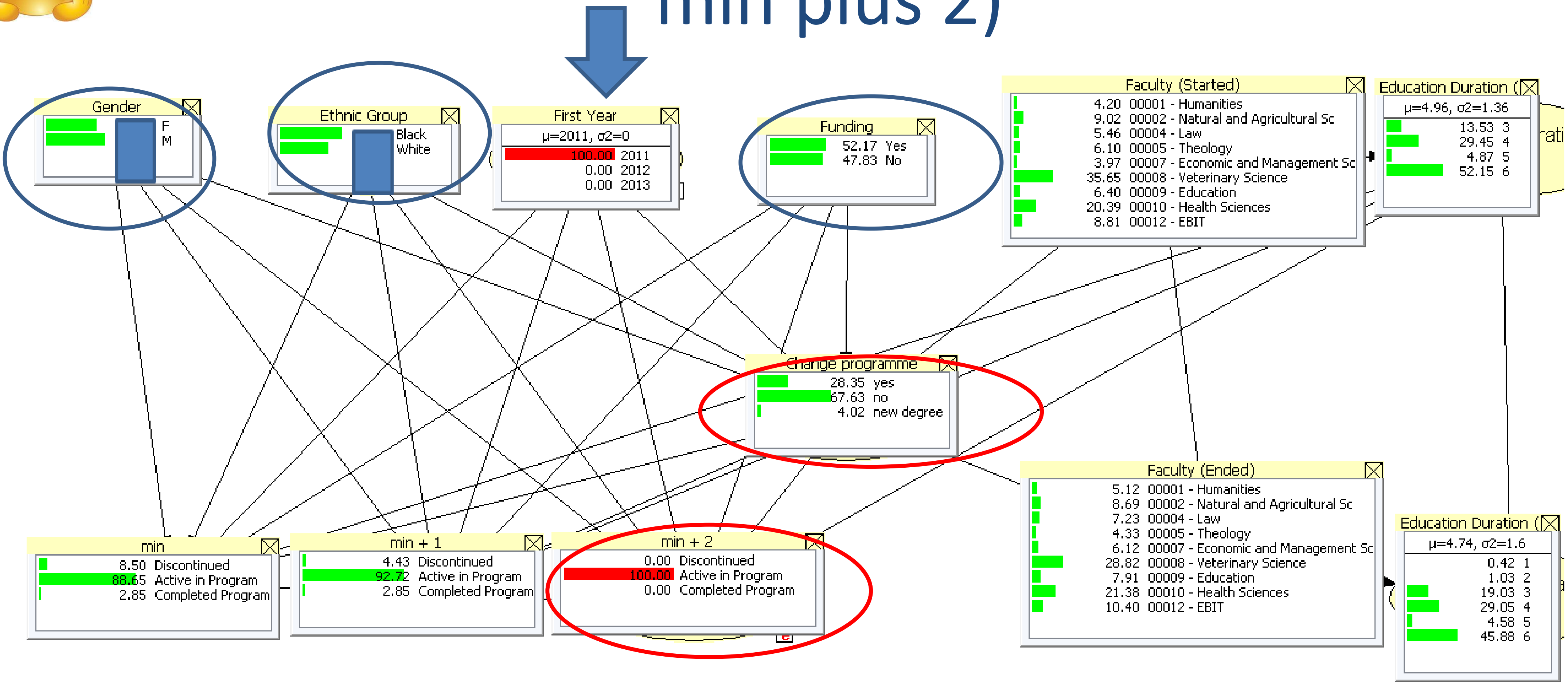


Best Case Scenario (Graduation time, min)



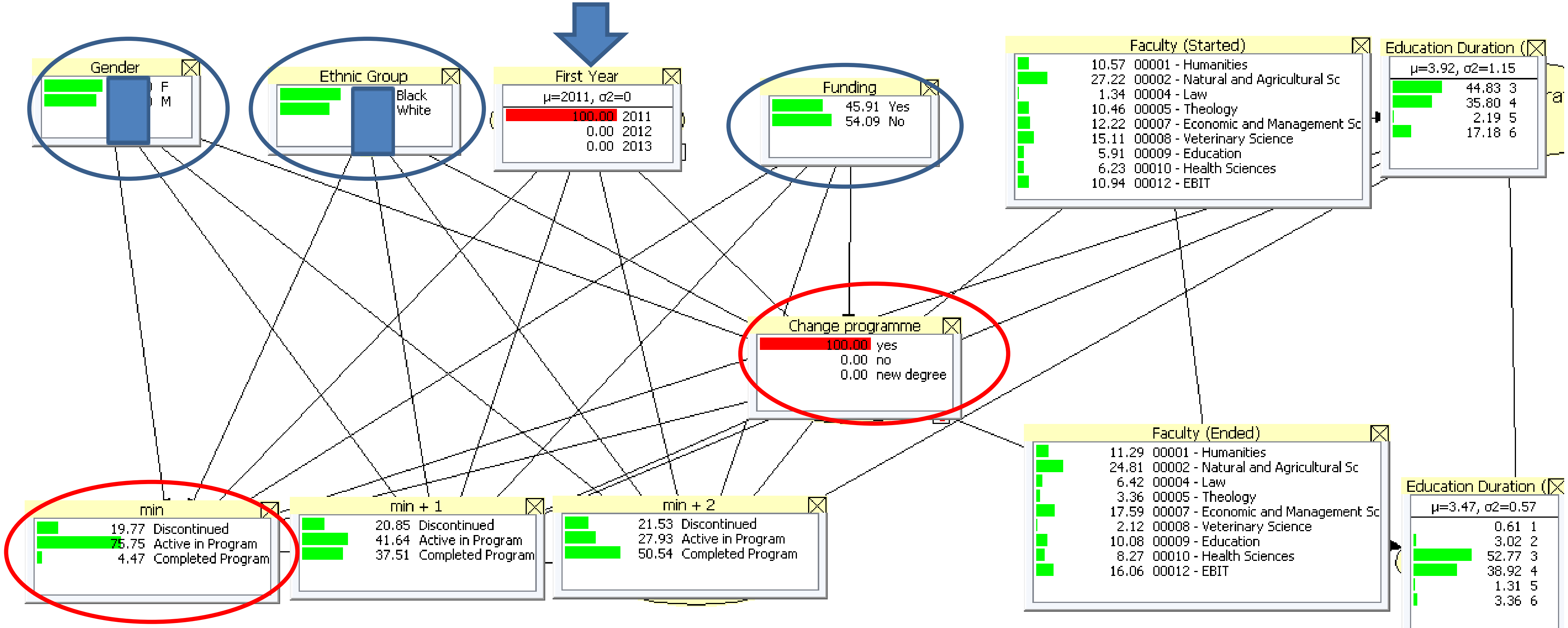
Control variables: Completed in min time and cohort = 2011
Associated student profile: White female students with financial support that do not change programme

Worst Case Scenario (Graduation time, min plus 2)



Control variables: Still active in min time plus 2 years and cohort = 2011
Associated student profile: More likely to be black male students with or without funding support that do not change programmes

Change programme : Yes



Control variables: Change program YES and cohort = 2011

Associated student profile: They are more likely to be still active after minimum time

Thank you!

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Student throughput analysis using a Bayesian Model : The case of Wits

SAHELA 2017 Workshop
University of Pretoria & University of the Witwatersrand

Southern African Association for Institutional Research

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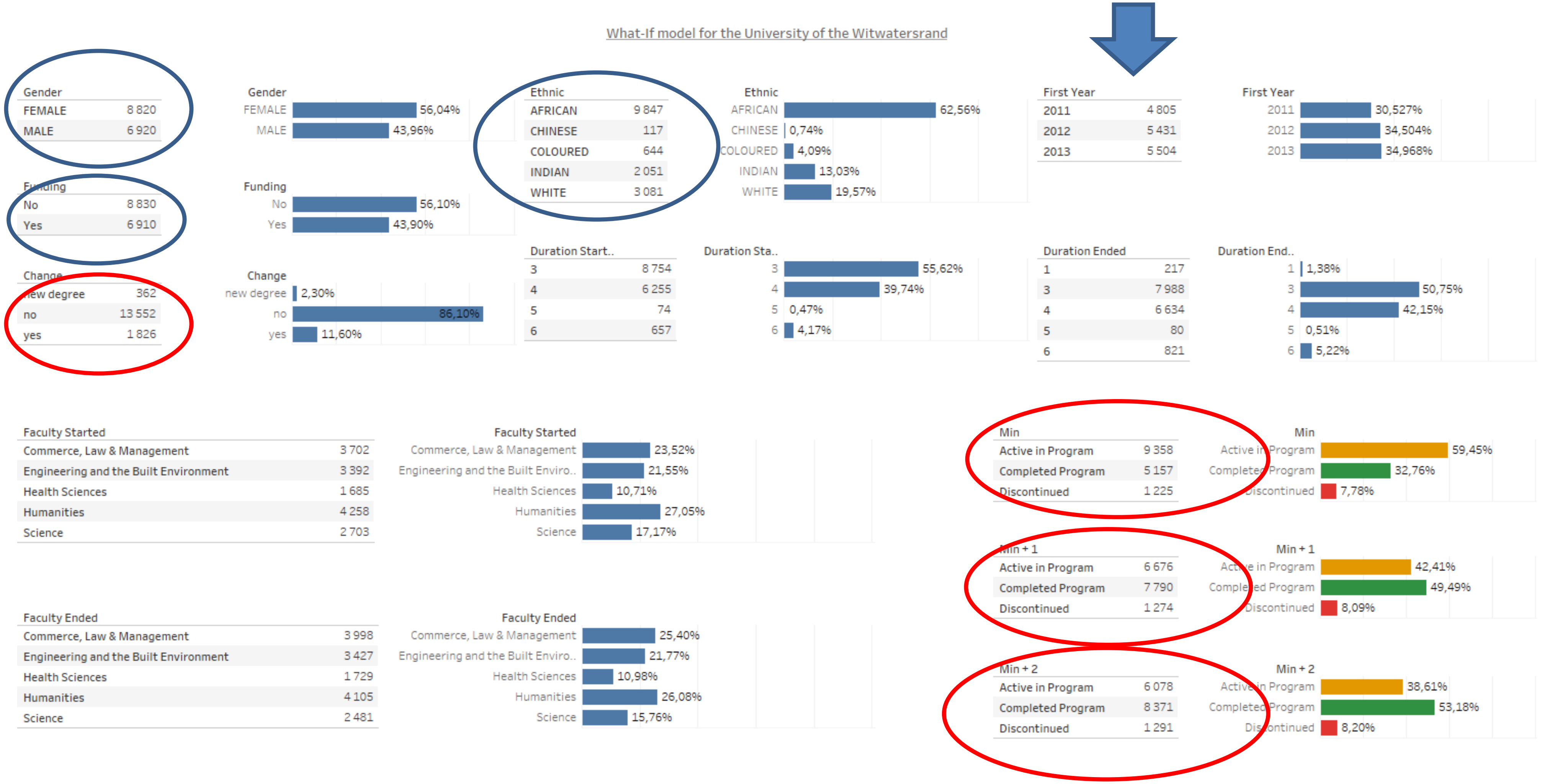
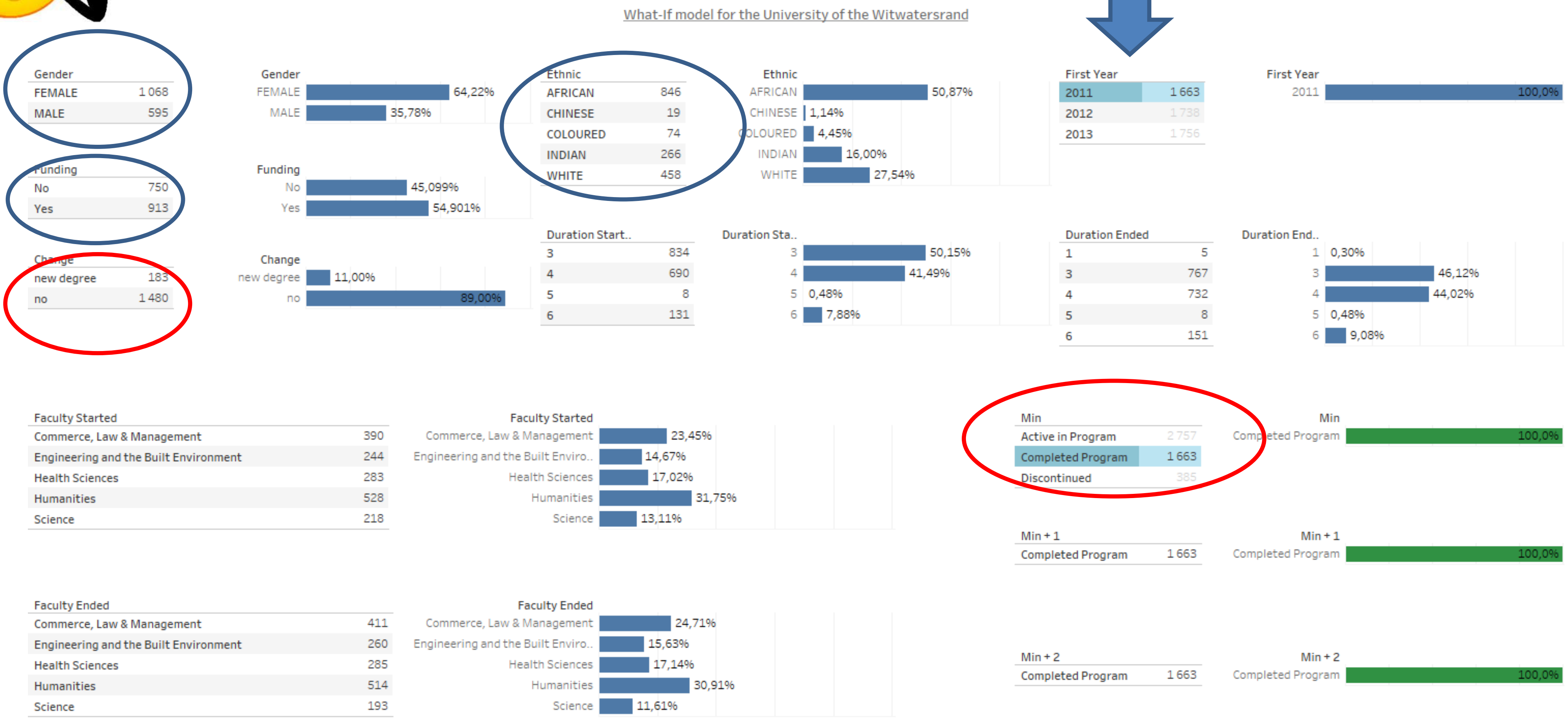
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Model (Institutional Level): Student throughput analysis

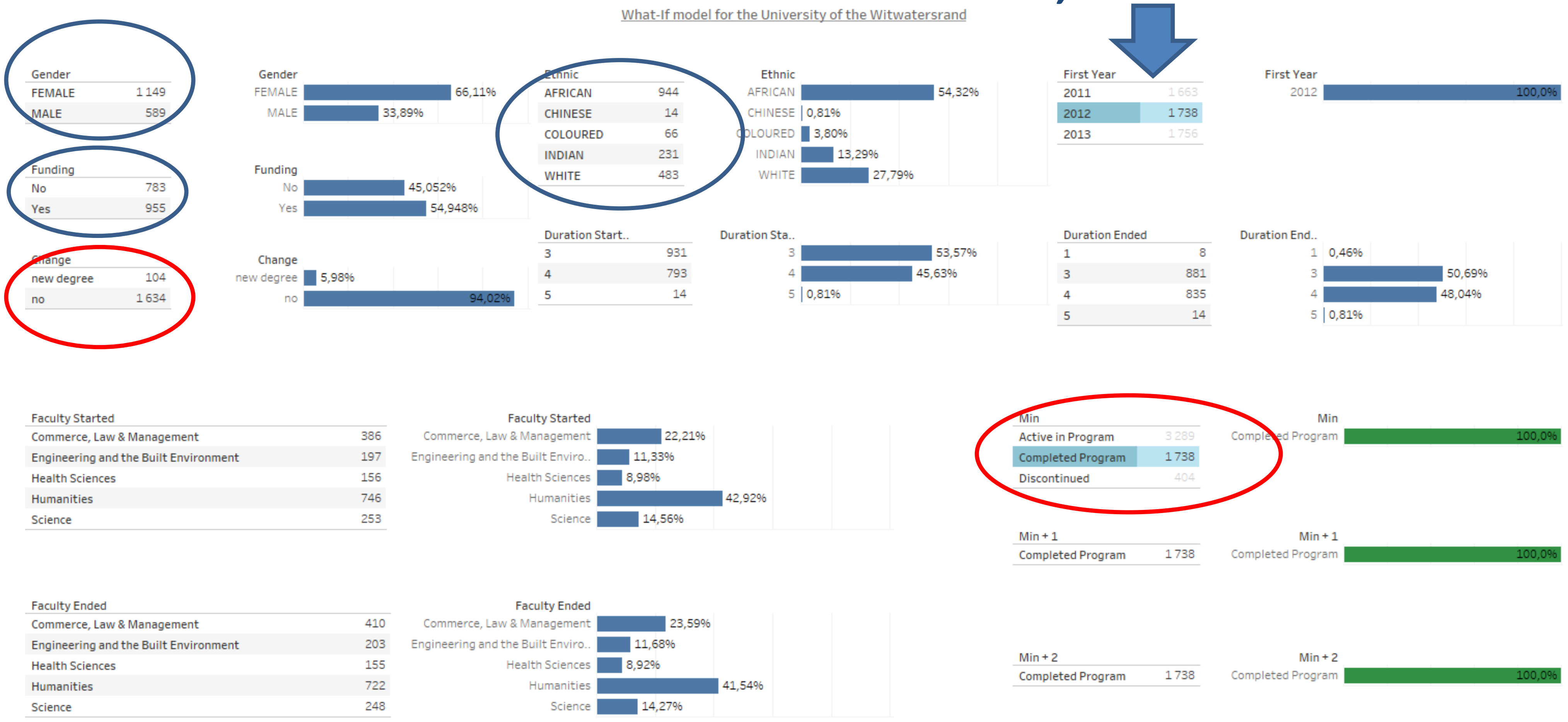


Best Case Scenario (Graduation time, min)



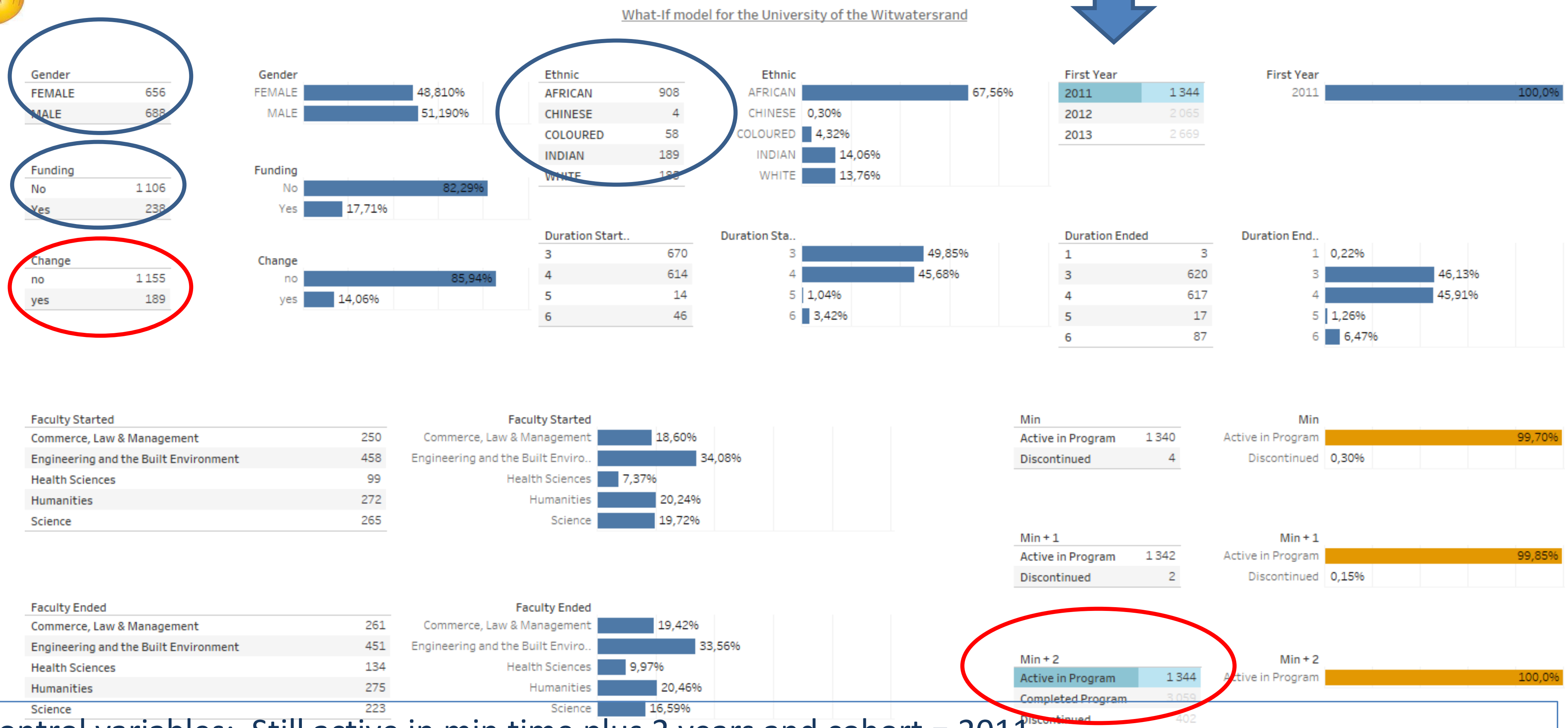
Control variables: Completed in min time and cohort = 2011
Associated student profile: African female students with financial support that do not change programme

2012 Cohort: Graduation time ,minimum time



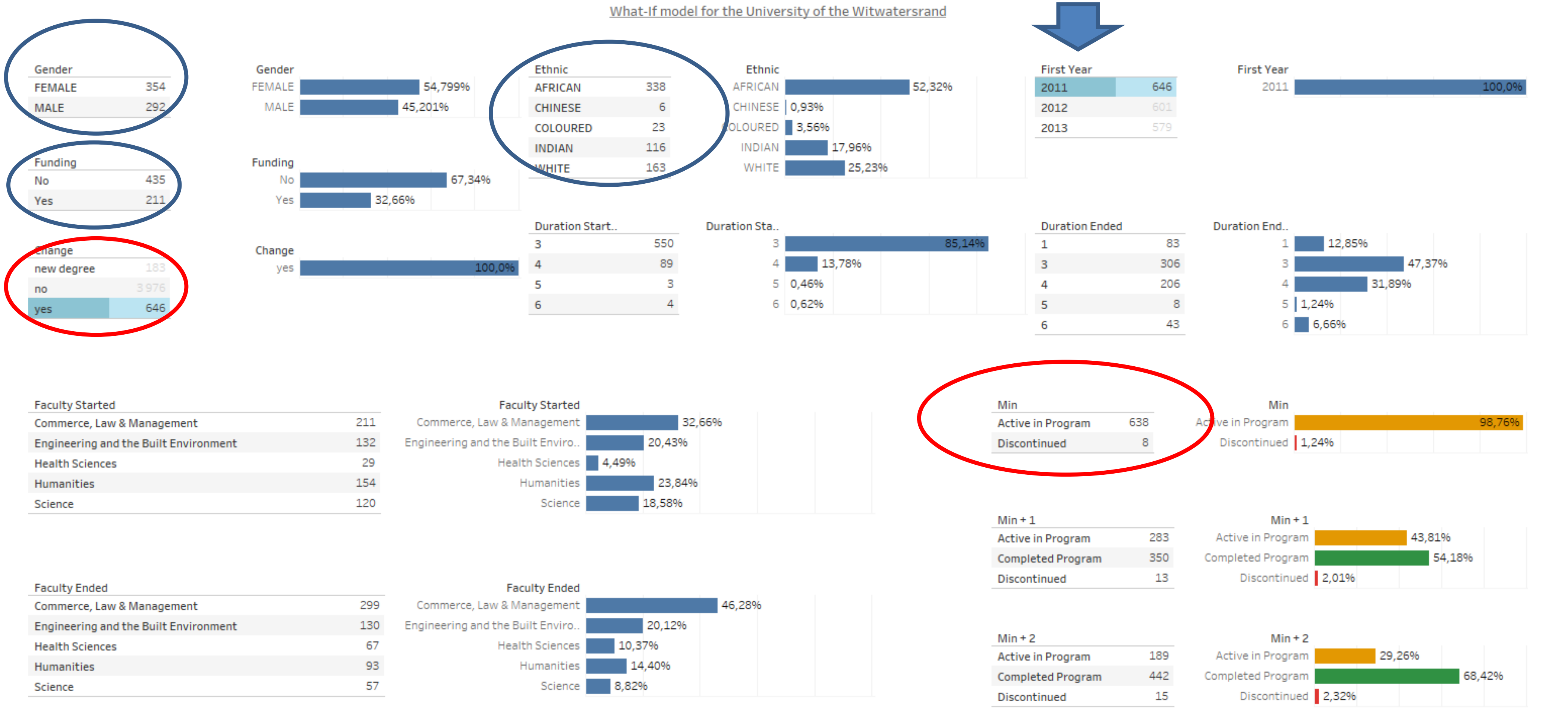
Control variables: Completed in min time and cohort = 2012
Associated student profile: African female students with financial support that do not change programme

Worst Case Scenario (Graduation time, min plus 2)



Control variables: Still active in min time plus 2 years and cohort = 2011
Associated student profile: More likely to be African male students without funding support and do not change programmes

Change programme : Yes



Control variables: Change program YES and cohort = 2011
Associated student profile: They are more likely to be still active after minimum time

Change programme: No

What-If model for the University of the Witwatersrand

Gender		
FEMALE	2 227	56,01%
MALE	1 749	43,99%

Ethnic		
AFRICAN	2 455	61,75%
CHINESE	27	0,68%
COLOURED	162	4,07%
INDIAN	579	14,56%
WHITE	753	18,94%

First Year		
2011	3 976	100,0%
2012	4 726	
2013	4 850	

Funding		
No	2 518	63,33%
Yes	1 458	36,67%

Change		
new degree	183	
no	3 976	100,0%
yes	646	

Duration Start..	Count	Duration Sta.. %
3	2 015	50,68%
4	1 763	44,34%
5	23	0,58%
6	175	4,40%

Duration Ended	Count	Duration End.. %
3	2 015	50,68%
4	1 763	44,34%
5	23	0,58%
6	175	4,40%

Faculty Started	Count	%
Commerce, Law & Management	968	24,35%
Engineering and the Built Environment	919	23,11%
Health Sciences	382	9,61%
Humanities	995	25,03%
Science	712	17,91%

Faculty Ended	Count	%
Commerce, Law & Management	968	24,35%
Engineering and the Built Environment	919	23,11%
Health Sciences	382	9,61%
Humanities	995	25,03%
Science	712	17,91%

Min		
Active in Program	2 119	53,29%
Completed Program	1 480	37,22%
Discontinued	377	9,48%

Min + 1	Count	%
Active in Program	1 457	36,64%
Completed Program	2 142	53,87%
Discontinued	377	9,48%

Min + 2	Count	%
Active in Program	1 155	29,05%
Completed Program	2 434	61,22%
Discontinued	387	9,73%

Control variables: Change program No and cohort = 2011
Associated student profile: They have a lower probability of completing in minimum time

In conclusions

Findings

- African females at the University of the Witwatersrand are more likely to complete in minimum time.
- Funding is interlinked with graduation in minimum time.
- Students who complete their programmes in minimum time, are more likely to have funding and less likely to change a programme.
- Students who change programmes are more likely to be still active after minimum plus 2 graduation time.
- Based on the model, funding and changing programme are variables that are most likely to impact on student's completion time.

[Hence] Impact

- Gain insight in institutional profiles for student success.
- Motivate faculties to focus more closely on initiatives to improve throughput rates.
- The university should focus on making student funding more available.

Thank you!

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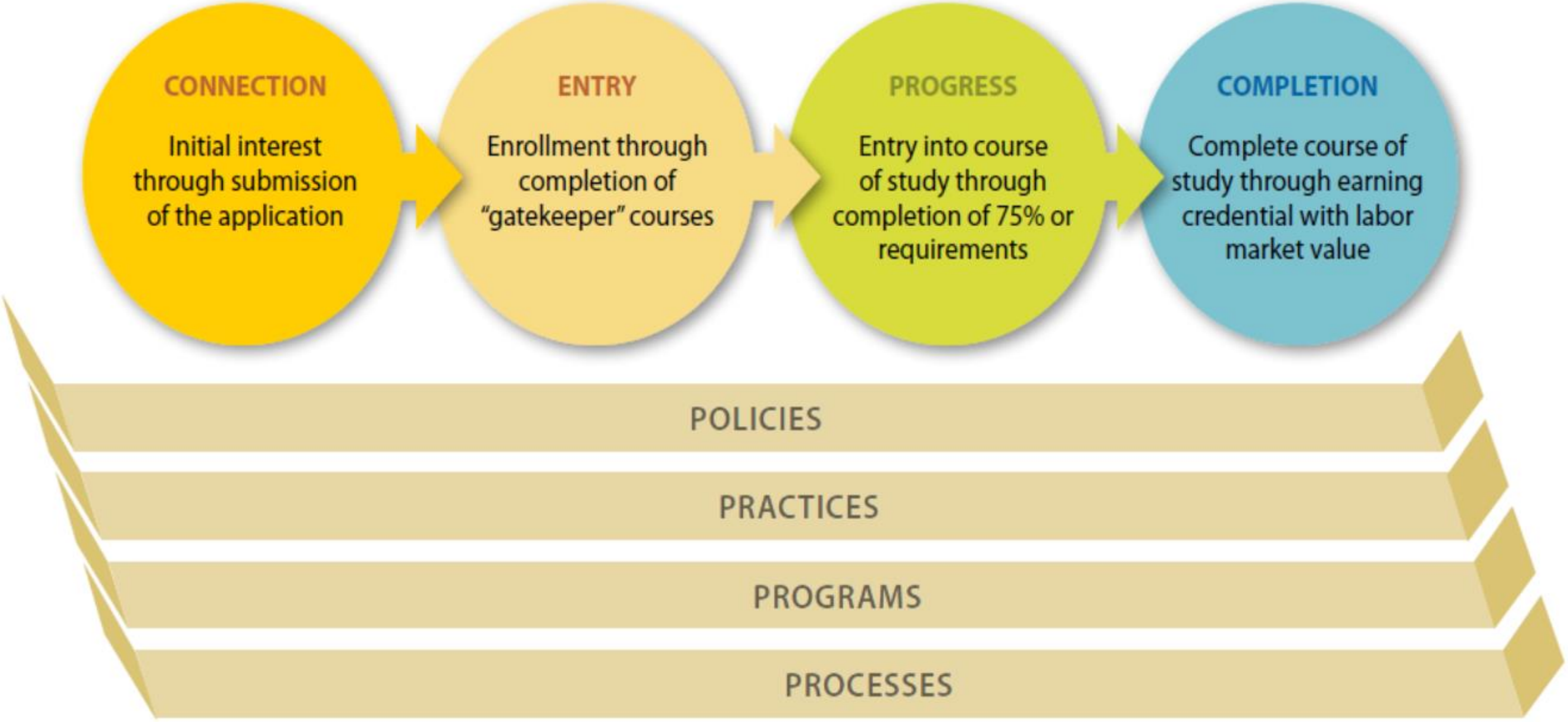
Theory of Change

SAHELA 2017 Workshop
University of Pretoria & University of the Witwatersrand

SA institutions are data rich but information poor?

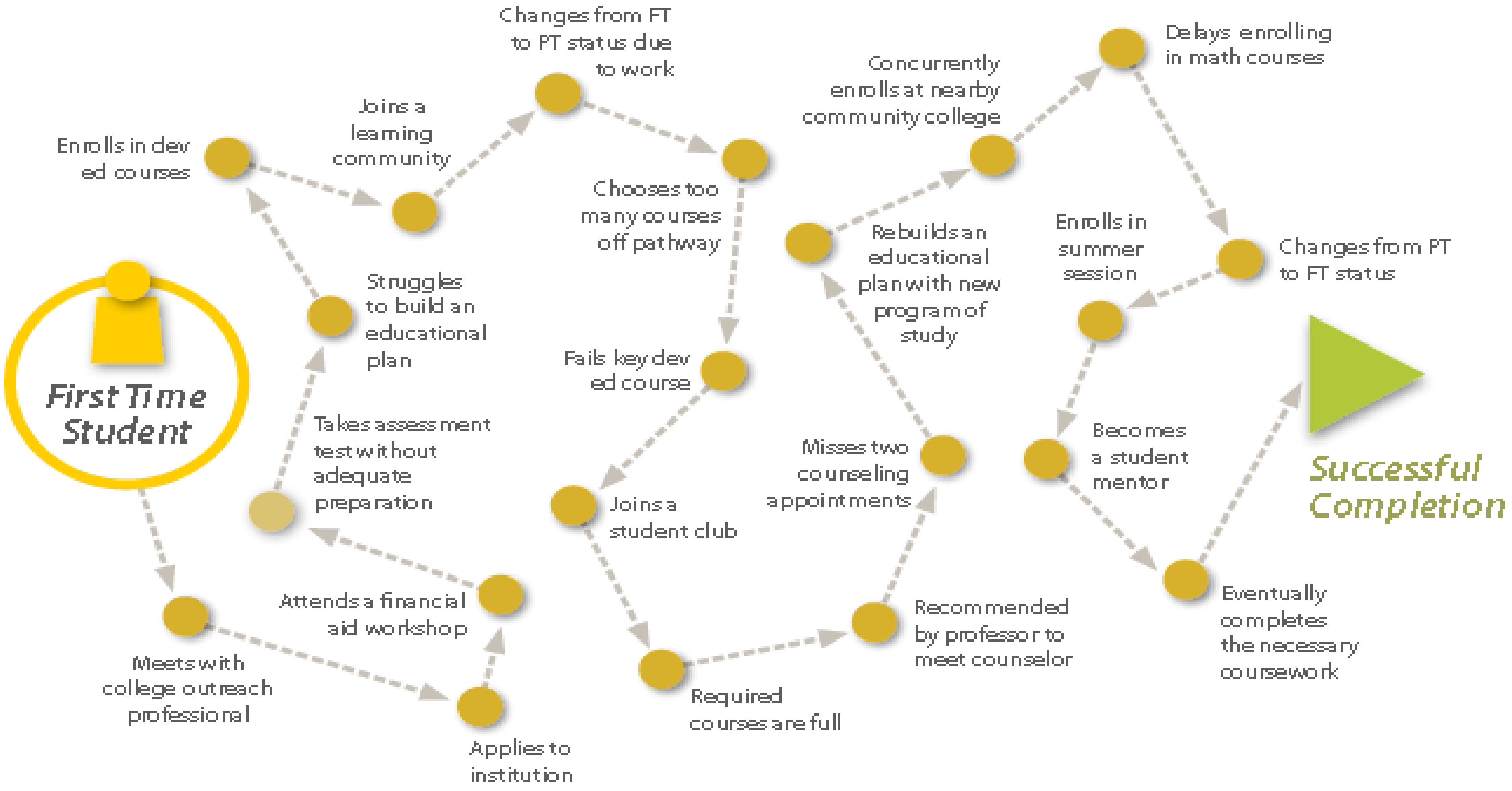
- Strategic planning: objectives and indicators/ scorecards
  - Success rates
  - Graduation rates
- Faculty plans
- Support departments objectives and indicators
- DHET reporting function
- Other: surveys, intervention evaluation, quality assurance activities, programme reviews

Integrated student experience?



Understanding The Student Experience Through The Loss/Momentum Framework: Clearing the Path to Completion

Student experience pathway



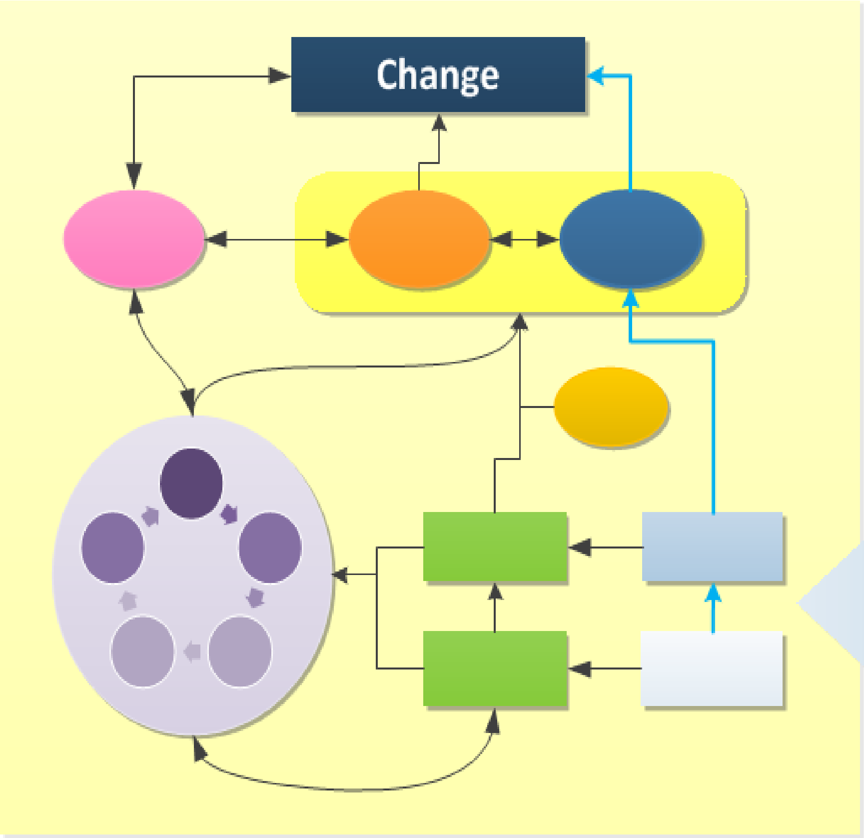
Understanding The Student Experience Through The Loss/Momentum Framework: Clearing the Path to Completion

Evaluation Frameworks

http://www.tools4dev.org/resources/theory-of-change-vs-logical-framework-whats-the-difference-in-practice/

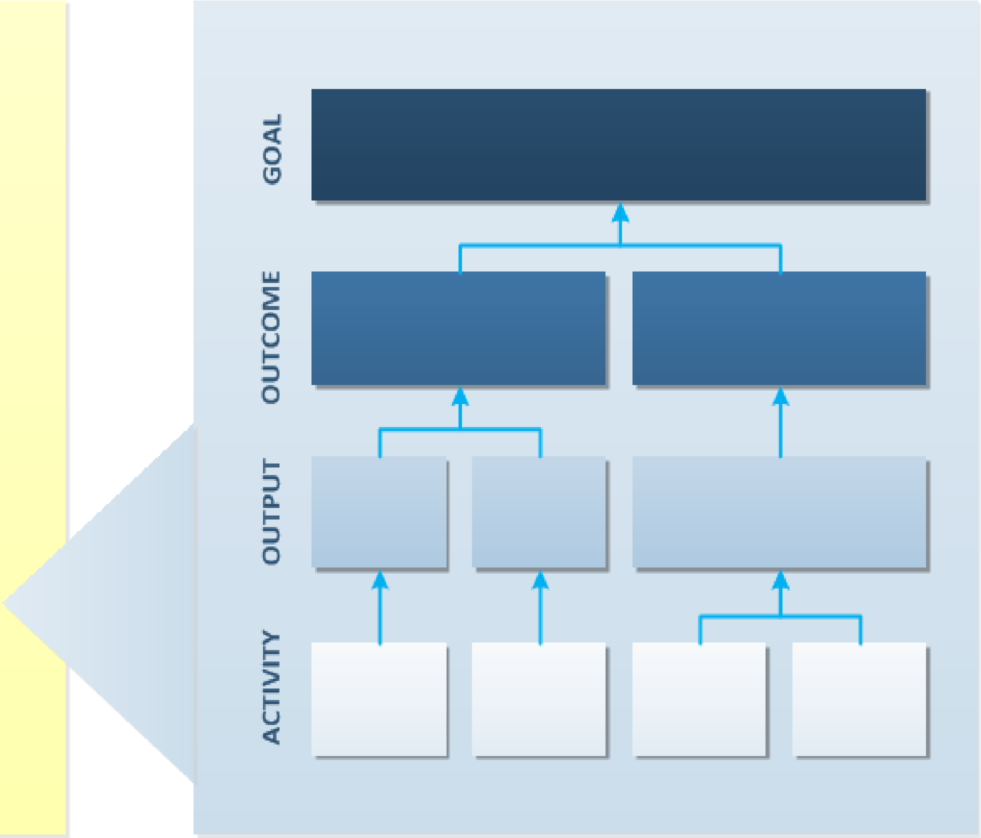
Theory of Change

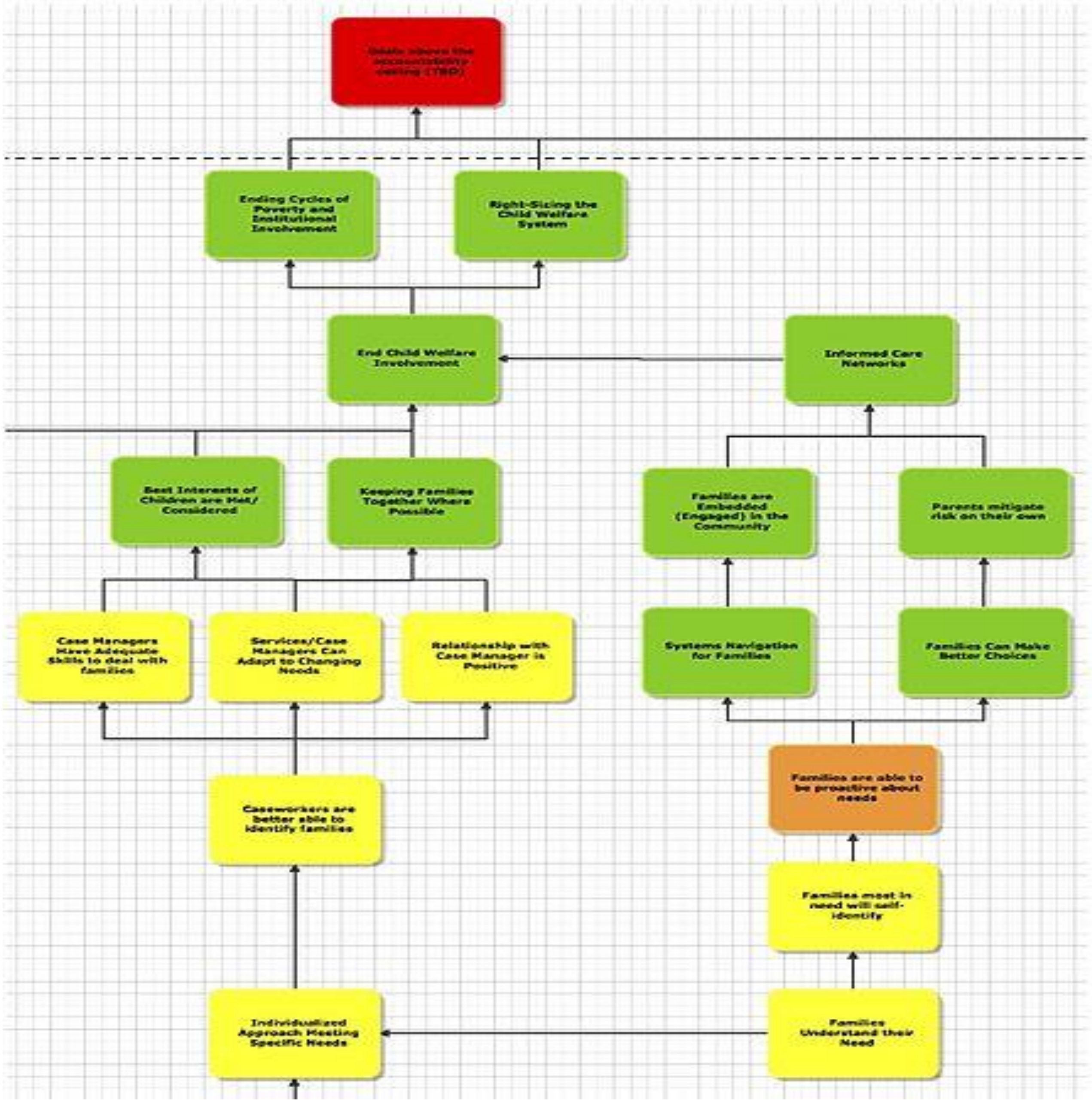
Shows the big picture with all possible pathways – messy and complex



Logical Framework

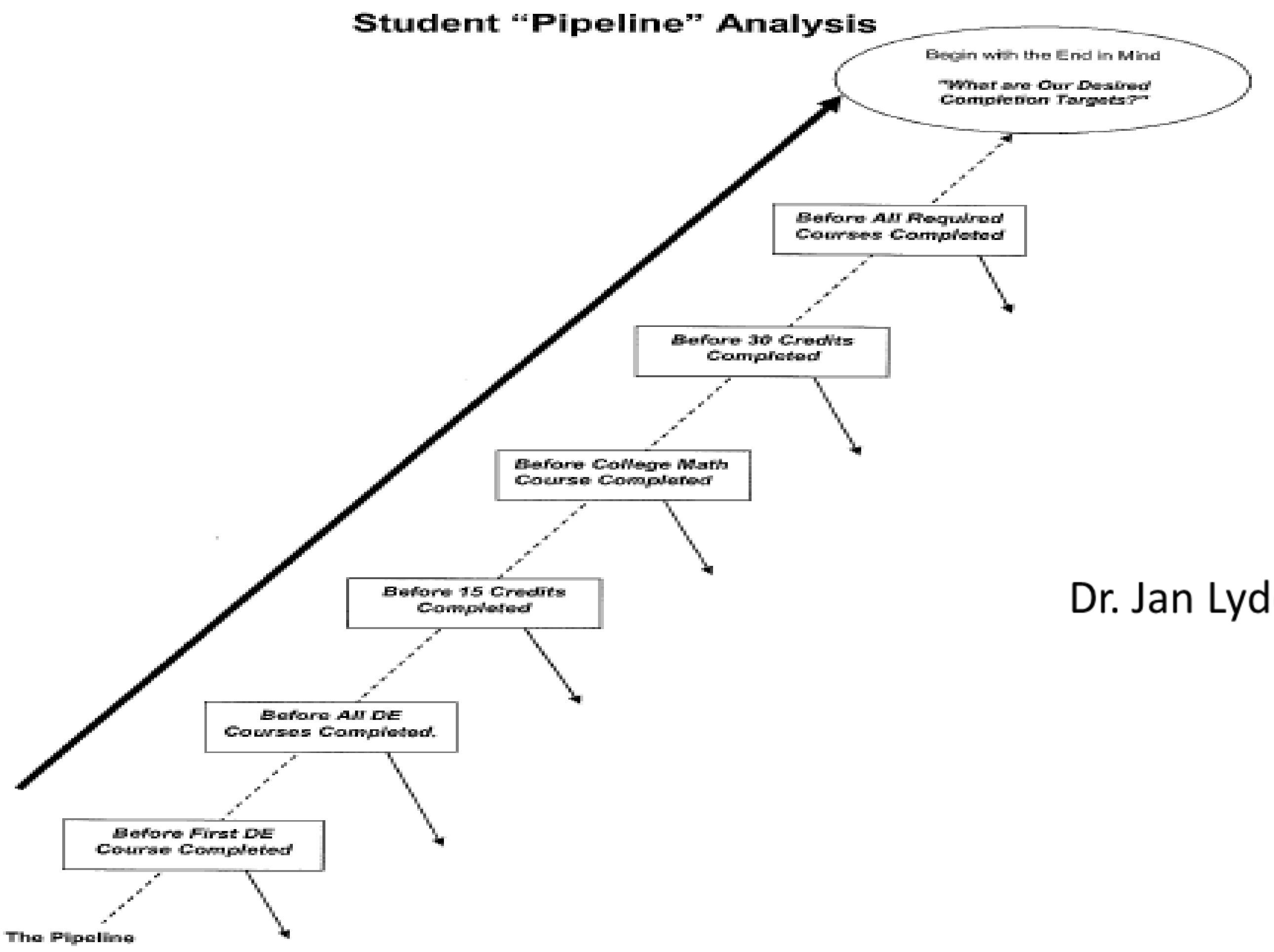
Shows just the pathway that your program deals with – neat and tidy





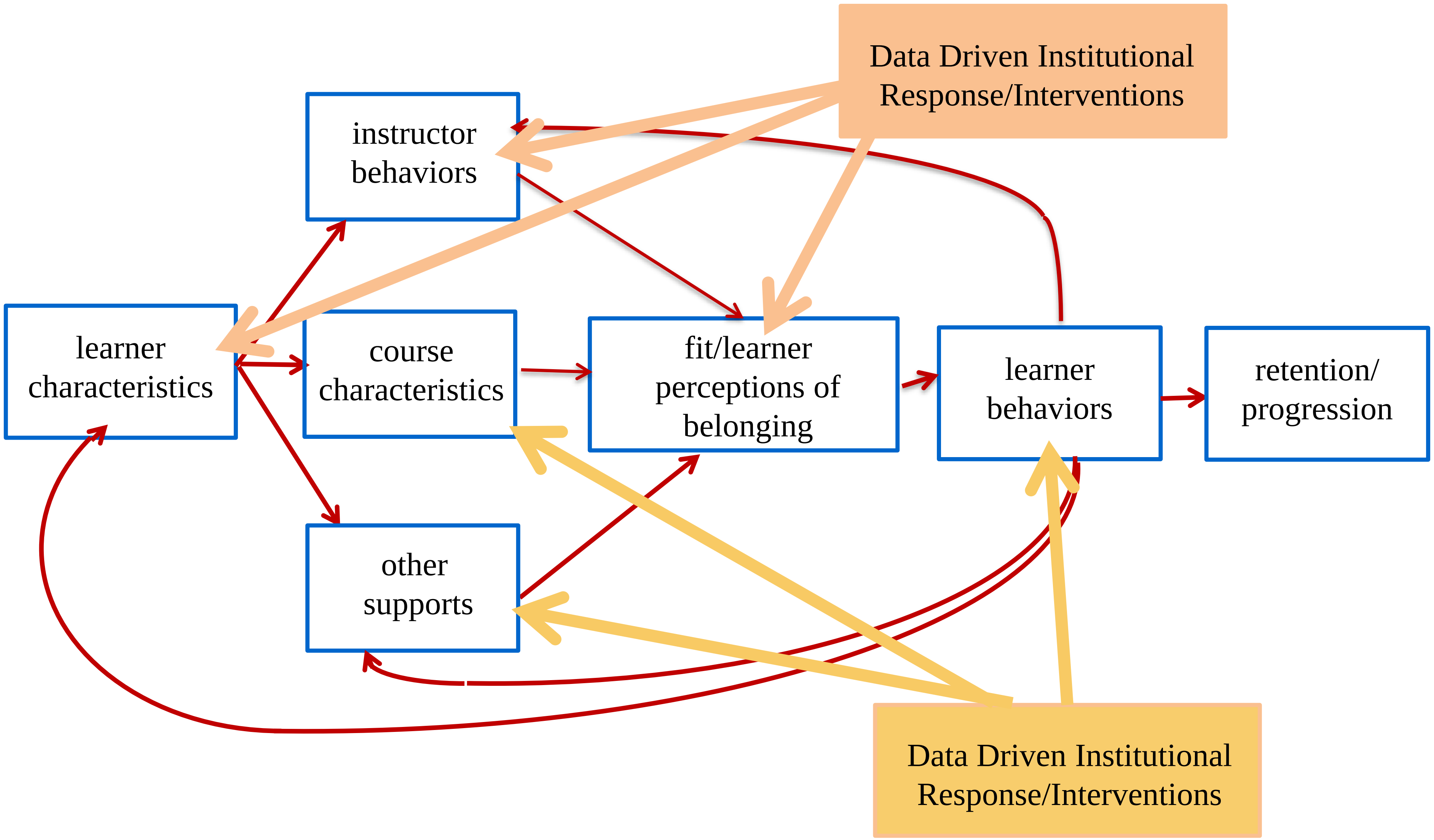
Ending Cycles of Poverty and Institutional Involvement
Right-Sizing the Child Welfare System
End Child Welfare Involvement
Informed Care Networks
Best Interests of Children are Met/ Considered
Keeping Families Together Where Possible
Families are Embedded (Engaged) in the Community
Parents mitigate risk on their own
Case Managers Have Adequate Skills to deal with families
Services/Case Managers Can Adapt to Changing Needs
Relationship with Case Manager is Positive
Systems Navigation for Families
Families Can Make Better Choices
Families are able to be proactive about needs
Caseworkers are better able to identify families
Families most in need will self-identify
Individualized Approach Meeting Specific Needs
Families Understand their Need

Student experience pathway



Dr. Jan Lyddon: Pipeline Analyses

Theory of Change/ Log Frame



Theory of Change

- Identifying long-term goals and the assumptions behind them
- Backwards mapping from the outcome variable by working out the preconditions or requirements necessary to achieve that goal and explaining why.
- Voicing your assumptions about what exists in the system without which your theory won't work, and articulating your rationales for why intermediate outcomes are necessary preconditions to other outcomes.
- Weighing and choosing the most strategic interventions to bring about your desired change.
- Developing indicators to measure progress on your desired outcomes and assess the performance of your initiative.
- Quality review should answer three basic questions: Is your theory 1) plausible, 2) "doable" (or feasible), and 3) testable?
- Writing a narrative to explain the summary logic of your initiative.

Activity

- Create a process map to visualise the student experience: explore how students move through your institution/ faculty and experience student services
- Include the four phases of the student pathway (Connect, Entry, Progress, Completion)
- Include the underlying factors that have an impact on the institution and the students (Policies, Practices, Programs, Processes)
- The outcome variable is the graduation rate (min, +1, +2) at the Faculty of Natural Sciences (Set the baseline and determine goals)
- Use a Theory of Change Process (start from the end and work backwards)

Activity

- Process map (ToC process)
- Determine ‘leakage points’ (entry at 100%)
  - Student characteristics, support services, policies, practices, etc.
  - What interventions are in place (any data to show impact?)
  - What educational practices are involved?
- Determine at each of the four phases
  - What technology is used
  - Who are the key role-players
  - What technology is used
  - What are the ‘disconnects’ (things that go wrong)
- What should change in order to meet the Goal?

References

- https://focusedunow.com/process-mapping-for-enrollment-and-retention-success/
- https://www.insidehighered.com/views/2016/09/27/redesigning-college-processes-student-mind-essay
- http://www.higher-education-marketing.com/blog/student-journey-mapping-personalize-optimize-conversion
- https://en.wikipedia.org/wiki/Theory_of_change
- http://www.bredeschool.org/sites/default/files/theoryofchangeguide%282%29.pdf
- https://er.educause.edu/articles/2013/12/the-predictive-analytics-reporting-par-framework-wcet
- http://www.parframework.org/
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Moving the needle (Institutional and National)

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Effectiveness of Learning Analytics (LA) Initiatives

- There is a growing literature on the effectiveness of LA:
  - Student retention
  - Students grades
  - Other Student success indicators

- Challenge is the difficulty in isolating & identifying the direct influence of the use of LA
  - often part of wider initiatives aimed at improving academic achievement & student success

(Sclater and Mullan, (JISC) 2017)

Effectiveness of Learning Analytics (LA) Initiatives

- LA systems enable universities to:

  - track individual student engagement, attainment & progression

  - flag any potential issues (tutors & support staff)

- This allows the earliest identification of the students at risk of dropping-out or under-achieving

- Predictive models (used by LA systems) are developed using historical data from previous cohorts of students

  - examining their patterns of activity & how these correlate with subsequent academic achievement

(Sclater and Mullan, (JISC) 2017)

Effectiveness of Learning Analytics (LA) Initiatives

Example:

Civitas Learning:

- Study on 23 institutions showed that student engagement with Virtual Learning Environment (VLE) was high predictor of student success

  - the most significant predictor of student success was the percentage of days that they logged onto the VLE during the first 14 days of the term

(Civitas Learning, 2016)

Effectiveness of Institutional Interventions

- The true value of LA becomes clear only when actions are taken with students on the basis of the data

- Various studies have been carried out involving control groups

  - demonstrating some of the most convincing evidence for LA in influencing student success

(Sclater and Mullan, (JISC) 2017)

Effectiveness of Institutional Interventions

Example:

University of South Australia

- 730 students across a range of courses identified as at risk

- Of the 549 who were contacted, 66% passed with an avg Grade Point Average (GPA) of 4.29

- 52% of at risk students who were not contacted passed with an avg GPA of 3.14

(Siemens, Dawson and Lynch, 2015)

Effectiveness of Institutional Interventions

- This shows the importance of intervention programmes in universities

  - if a student has been identified as at risk and they are left alone, they are more likely to fail

- Once a student has been flagged as being at risk, LA can help universities to understand which interventions work best

- By using proxies to measure student engagement, universities can examine how effective an intervention is

(Sclater and Mullan, (JISC) 2017)

Effectiveness of Institutional Interventions

- Currently, there is increasing focus on the efficacy of spending on access and student success

    - LA can help institutions to review & demonstrate the effectiveness of their student support

- Other studies suggest that by simply making the students to be aware that they are at risk, may be enough

(Sclater and Mullan, (JISC) 2017)

Effectiveness of Institutional Interventions

Examples:

Marist College case study

- There was a positive impact on grades for those students who were able to view comparative data on their engagement and progress

Nottingham Trent University

- A survey of the first year students showed that 27% of the students changed their behaviour in response to data on their LA dashboards

(Foster, 2015)

South African Learning Analytics Initiatives

SAHELA

- Launch of the SAHELA (South African Higher Education Learning Analytics) in 2013 by UP (in collaboration with Learning Analytics Summer Institute)

  - since then a number of workshops have been organised as part of the SAAIR

- ***Proposed Way forward:***

  - SAHELA to be incorporated as part of the SAAIR

  - Have more universities participating in the workshops

(Jordaan and van der Merwe, 2015)

South African Learning Analytics Initiatives

Siyaphumelela – '*We Succeed*' Initiative

- Launched in 2015
- Initiative funded by the Kresge Foundation

- ***Overall aim:***

'to help SA universities by strengthening their internal capacity to collect student data & address student success issues on their campus'

- ***Specific objectives:***

  - create SA models of universities using successful data analytics to improve student outcomes

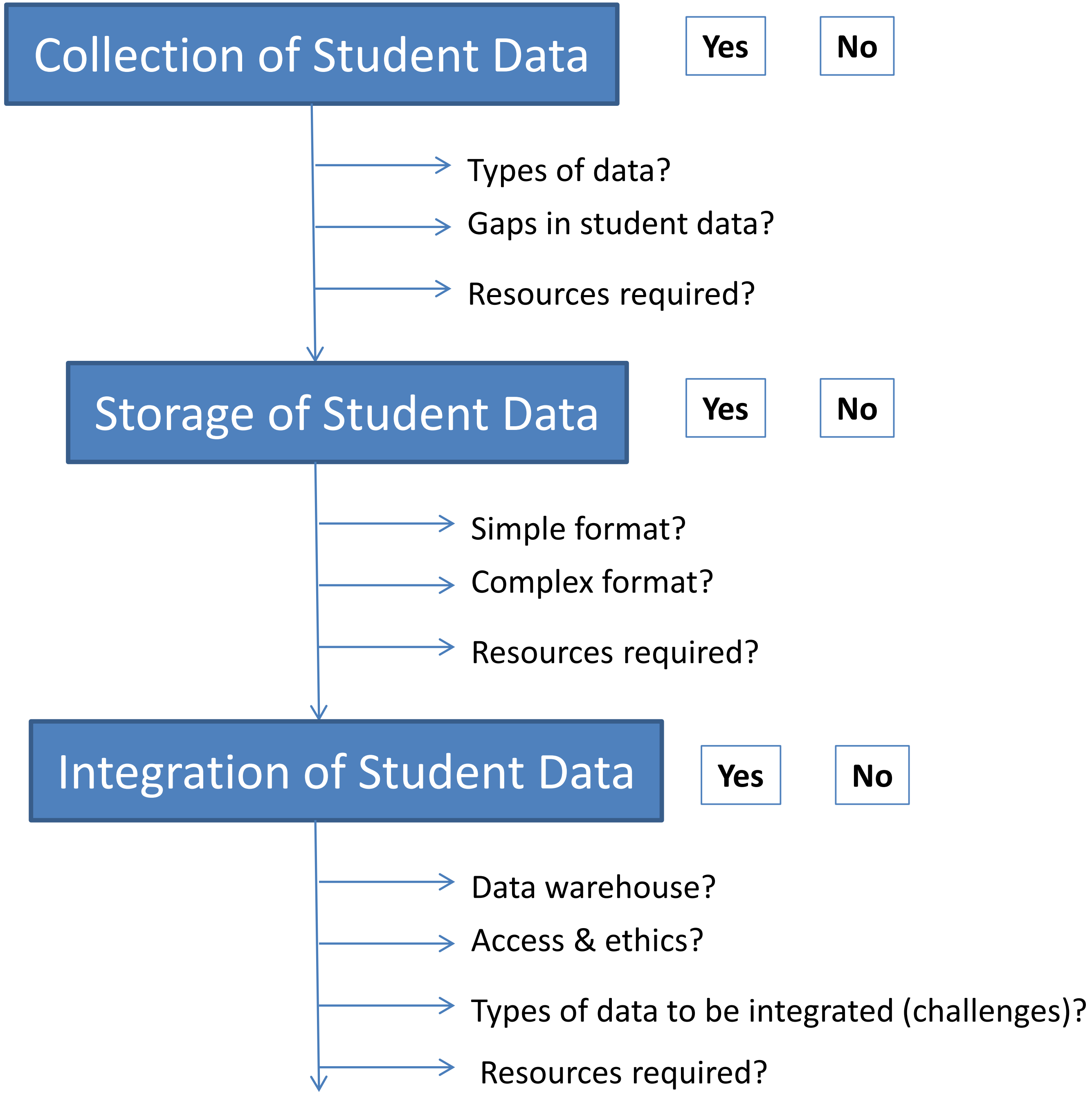
South African Learning Analytics Examples

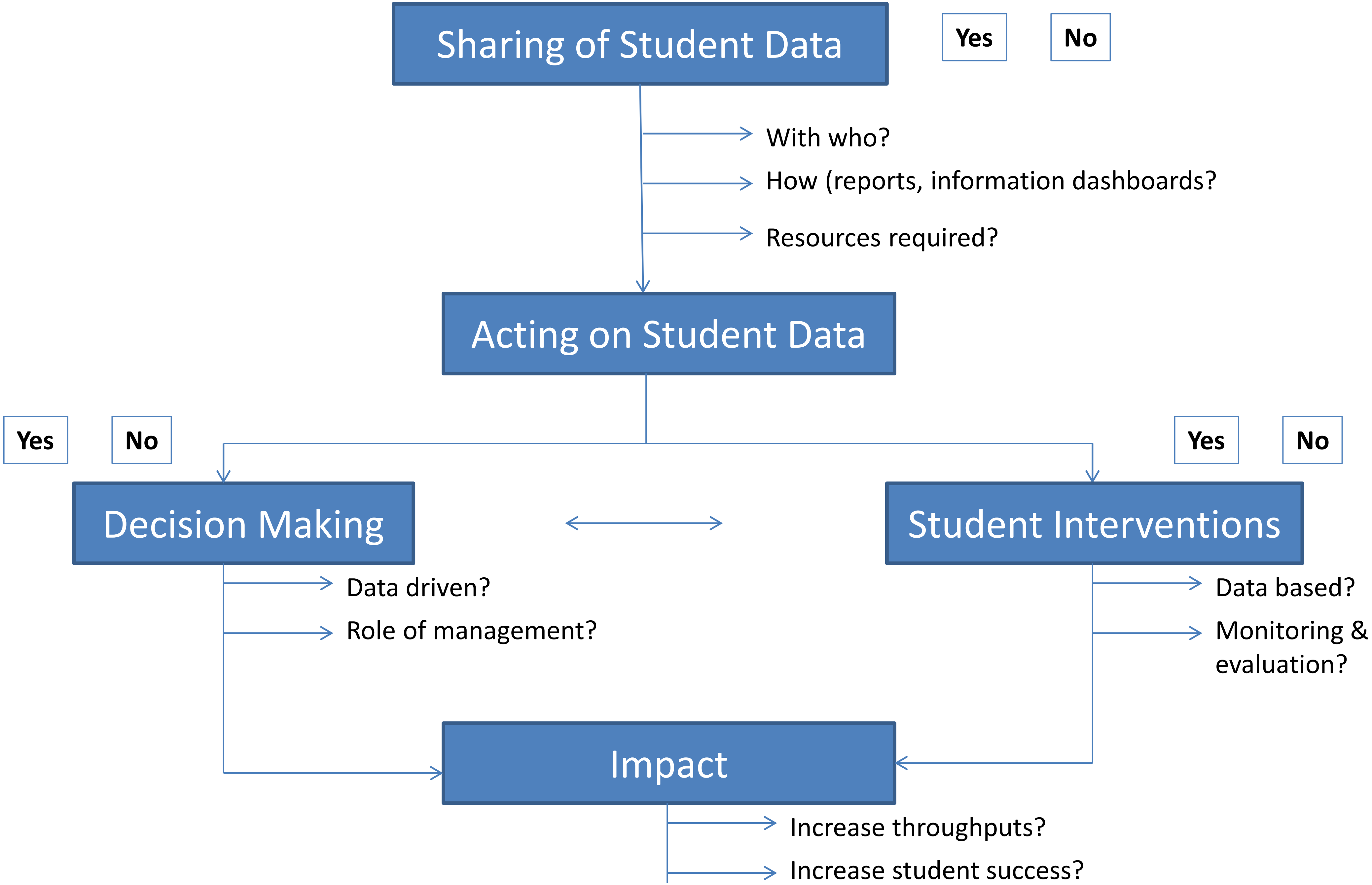
- ***Impact of initiative so far***:

  - sharing of data among the 5 partner universities (*DUT, UP, Wits, NMMU, UFS*)

  - focused tackling of student success issues (student advising, data handling, ethics, etc.)

Open Discussion


Collection of Student Data
Yes
No
Types of data?
Gaps in student data?
Resources required?
Storage of Student Data
Yes
No
Simple format?
Complex format?
Resources required?
Integration of Student Data
Yes
No
Data warehouse?
Access & ethics?
Types of data to be integrated (challenges)?
Resources required?



Sharing of Student Data
Yes
No
With who?
How (reports, information dashboards?
Resources required?
Acting on Student Data
Yes
No
Yes
No
Decision Making
Student Interventions
Data driven?
Role of management?
Data based?
Monitoring & evaluation?
Impact
Increase throughputs?
Increase student success?

Thank you!

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Closure and conclusion

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