CRITICAL SYSTEMS THINKING IN EDUCATION: A LITERATURE PERSPECTIVE AND DEMONSTRATION

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Abstract

For people who are illiterate, the opportunities for employment and improving their situation presents an overwhelming challenge. In the world of the 21st century people who are data illiterate, will increasingly find themselves in the same situation, irrespective of their field of employment. Companies and society need people who can analyse data and use the resulting information to direct decisions.

Another aspect of the 21st century that society struggles with, is the increasing prevalence of mental illness due to work pressures, failing marriages, torn family structures, isolation and so forth. The mental health of students is a major cause for concern since one in three students show signs of depression and anxiety.

Within this context there is a need to develop a plan to address the instructional design for data science students. They need to learn relevant content in a manner that will equip them to succeed in the workplace and society at large within a context where their wellbeing will be nurtured.

The study employs the Systems Informed Positive Psychology perspective to direct the process of improving the design of data science modules. Critical Systems Thinking determines how different components are interlinked, and how they can best be changed to attain the overall goal by listening to the voices of all the affected parties. Directed content analysis of comments received from 284 students participating in an introductory statistics module at a South African university indicates that students intuitively mentioned several aspects of the Flourishing Classrooms Systems Model, thereby indicating that students would like a thriving classroom.

The students' voice indicated that things like emotional bonding and supportiveness are important to them. Little classroom flexibility is experienced by the students, it may be due to lecturers who are lacking in leadership in the classroom and are unwilling to negotiate on matters with the students. Students indicated the importance of proper classroom communication – clarity and listener skills are crucial for students to flourish in a class. Finally, several aspects of classroom wellbeing were mentioned: strength focus rather than zooming in on shortcomings, lecturers' emotional management, students' increased attention through active learning, improved coping through better planning and time management, and the forming of good study habits.

This study shows that by employing systems thinking, the inter-connectedness of diverse factors emerged more clearly, enabling educationists to develop better solutions that may make a difference in the lives of many students.

Keywords

Data science education, systems informed positive psychology, flourishing classroom, positive education.

1| Introduction

With the onset of the fourth industrial revolution and the amounts of data generated every day, there is an urgent need for all students to be data literate, meaning that they should understand some basic statistics, how to generate and interpret meaningful graphs and how to use statistics to extract information that can drive business decisions and address the societal problems we are facing, and will be facing in future (LaMar & Boaler, 2021). It is therefore important that data science educationists keep this in mind and develop the learning material and the learning experience to enable students to handle the data challenges when entering the workplace.

The world we live in is becoming more fast-paced by the day and the social environment students find themselves in (especially since the COVID-19 pandemic has caused more isolation, stress and health issues) is not conducive for overall wellbeing. A meta-analysis on higher education students based on eighty-nine studies (n=1,441,828) indicated the prevalence of depression, anxiety and sleep disturbances as 34%, 32% and 33%, respectively (Deng et al., 2021). Universities need to address this, not only by providing counselling services, but also by changing education to improve the wellbeing of students and not only focusing on delivering content.

This article makes use of the systems informed positive psychology perspective to guide the instructional design of data science modules by using a flourishing classroom model.

2| Literature perspective: Systems thinking and positive education

The following will be discussed: critical systems thinking, positive education, systems informed positive psychology, and the flourishing classrooms systems model.

2.1| Critical Systems Thinking

"Systems thinking begins when first you see the world through the eyes of another" (Churchman, 1968, p. 231). He explains that the purpose of the systems approach is to enable logical decision-making while steering clear from rigid thinking through careful depiction of the nature of the system. He asks why the world's problems, that could in principle be solved, have not been solved yet and reasons that it is due to the interconnectedness and overlapping of the problems, which make it very difficult to know where to begin. The systems approach deals with this problem by promoting holistic thinking and serves as a guide to a problem solver to address intricate real-world problems. According to Jackson (2003) systems thinking is used to solve complex problems by employing holistic thinking. Holism views systems as being more than merely the sum of their parts: it also considers the complicated relationships between the parts and how they sustain the new whole entity. Systems thinking is valuable because it places emphasis not only on the structure, but also on the process.

Churchman (1968) lists five characteristics of a system: the total objective of the system, its environment, its resources, its components, and the management thereof. A brief explanation of the characteristics, as described by Churchman, follows.

The total objective of the system is the overall quantifiable goal of the system. All the components of the system should work together to attain this objective. Other objectives may be sacrificed to reach this goal if the need arises. It is important to note that the real objective is sometimes different from what the role players may state as the objective, for instance students may state that their objective is to acquire knowledge when their real objective is to obtain a degree. A university may state that their goal is high quality research and excellent teaching, but their true objective may be to obtain as high a throughput of undergraduate and postgraduate students as possible to attain more government funding.

The environment of the system is everything that may have an impact on the system but is outside the boundary of the system. To determine if something belongs to the environment of the system, it is useful to ask if anything can be done about it and if it matters relative to the total objective of the system. If it matters but is beyond the control of the system, it belongs to the environment.

Resources, on the other hand, are everything inside the system that can be utilised and controlled to accomplish the overall objective, such as manhours, workforce skills, finances, classroom space, office space and equipment. Not only should current resources be studied, but also ways on how to increase or improve resources, e.g., by research, development, training, and education.

Components can be viewed as smaller sub-systems of the system that interact and have clear sub-objectives that should be aligned with the ultimate objective of the system.

The management of the system plans the activities of the components to reach their sub-objectives by allocating the resources efficiently, managing the system's performance to realise the system's overall objective.

Apart from the above mentioned, Churchman (1968) also states that people are a vital component of a system. Ulrich (1983) builds further on the ideas of Churchman and specifically addresses the plight of those affected by systems, but who have no control over these systems. He presents an approach that advocates emancipatory thinking where affected parties should have the opportunity to influence decisions regarding systems that affect them, thereby trying to counter possible unfairness. This is called Critical Systems Thinking (CST).

Jackson (1991) summarises the five commitments of CST: critical awareness, social awareness, emancipation of the individual, pluralism at the methodological level and pluralism at the theoretical level. Critical awareness refers to the need to critically scrutinise the assumptions as well as the values of current and future designs. Emancipation refers to the maximum development of the potential of the individual. Societal and organisational pressures and the consequences of actions are represented by "social awareness". Methodological pluralism means that methodologies from different systems traditions may be followed, whereas theoretical pluralism refers to the theoretical properties of different systems thinking mindsets.

For a better understanding of how to address students' psychological challenges, positive education will be introduced.

2.2| Positive Education

Positive psychology studies the thoughts, feelings and behaviour of people that enable them to focus on their strengths and designing a good life for themselves, in contrast to focus on their weaknesses and trying to repair a dysfunctional life (M. Seligman & Csikszentmihalyi, 2000). "Positive education is defined as education for both traditional skills and for happiness" (M. P. Seligman, Ernst, Gillham, Reivich, & Linkins, 2009). In Positive Education (PE) the principles of

positive psychology are incorporated into the educational system to ensure not only the acquiring of knowledge, but also acquiring the skills to be a happy, well-rounded person. Fostering flourishing and positive mental health within an educational community is the objective of positive education (Norrish, 2013).

There are different ways to incorporate positive psychology in the educational environment. It can be taught by using well-researched evidence-based programs such as the Penn Resiliency Program that is used to increase students' ability to handle problems, be decisive, how to brainstorm, make decisions and relax (M. P. Seligman et al., 2009).

Allison, Waters, and Kern (2021) explains that criticisms against PE state that it focuses on content over context and on individual flourishing, rather than on that of a group. They also explain that many factors that influence a student's wellbeing is outside the student, e.g., school environment, classroom climate, teacher wellbeing, teacher-student relationship, relationships with peers and feelings of connectedness. They argue that it is necessary to consider a systems approach that will study collective interventions that cultivate both the wellbeing of students and classrooms. Such an approach (explained in the next section) will provide understanding on how different components of the educational system influence one another, and how they can be altered to encourage both learning and wellbeing.

2.3 Systems Informed Positive Psychology

Systems Informed Positive Psychology (SIPP) was developed by Kern et al. (2020) to propose the use of systems thinking to better address the application of positive psychology within complex social systems such as education.

Having a mutual purpose, drawing on systems principles and making assumptions (concerning epistemology, politics, and ethics) form part of SIPP. All of this is grounded in the broader supposition that people co-exist with themselves, others, and their environment (i.e., inter-being) in an inter-dependent manner.

Kern et al. (2020) explains these concepts as follows.

2.3.1| Shared purpose

 SIPP aims to create conditions that will enable human social systems to thrive while also empowering the individuals within the system. It intends to succeed in doing this by acknowledging the complex inter-relatedness of a system and using a systematic approach that takes collectively negotiated values of all stakeholders into consideration.

2.3.2| Systems principles used in SIPP

Systems consist of different connected, interdependent components. The interdependency contributes to the complexity of the system; therefore, one cannot address a problem in the system in isolation. In systems thinking the defining of boundaries is crucial since that affects which areas are considered and who will be included as stakeholders in the fact finding and decision-making process, and who will be excluded. Different stakeholders may have different perspectives and therefore they should be provided the opportunity to let their voice be heard. A well-functioning system shows adaptation when its interconnected components develop

cooperative behaviour. Emergence takes place when innovative characteristics and patterns emerge as elementary components interact and self-organise.

2.3.3| Philosophical assumptions of SIPP

The epistemological assumption is that although there exists an objective reality, no single perspective encompasses that reality. Therefore, better understanding emerges when multiple perspectives using a wide range of methods is used.

The political assumption is that the stakeholders within a system should negotiate their power, rights, and responsibilities. Their perspectives may be very diverse and should be tolerated. While individuals have the right to wellbeing, they also have associated responsibilities.

The ethical assumption is that wellbeing should be defined in terms of what is collectively good and optimal for the group, not only for the individual. When addressing people's wellbeing, their perspectives, socio-historic background, and established community values cannot be ignored.

2.3.4| Inter-being

SIPP adopts the notion that 'humans inter-dependently co-exist with themselves, others, and the environment in which they exist', named by Hahn as inter-being (Kern et al., 2020, p. 709). SIPP doesn't focus only on the individual, but also takes the broader social and non-social systems that affect the individual into consideration.

SIPP differs from most positive psychology interventions in that it incorporates the broader social systems in which the individual system is embedded. By doing so a voice is given to the different perspectives within the boundaries of these systems to determine what outcomes are desired and which processes can be followed to attain them.

The SIPP perspective makes use of systems thinking in the field of positive psychology and is therefore an ideal framework to use for the development of a model that addresses the wellbeing of students.

Allison et al. (2021) developed a model that focuses on classroom systems by making use of SIPP. Through the systems approach, wellbeing can then be viewed as a collective experience, in addition to the individual experience. From the SIPP approach it follows that the educator is a change agent who can introduce creative ways that foster learning as well as wellbeing. Allison et al. (2021) utilised the Classroom Systems Observation Model (CSOM), developed by Fish and Dane (2000), and improved it by adding another dimension and naming it the Flourishing Classrooms Systems Model (FCSM).

2.4 Student wellbeing: The Flourishing Classrooms Systems Model

The FCSM combines the three dimensions of the CSOM model — cohesion, flexibility and communication — with another dimension, wellbeing (see Exhibit 1). Allison et al. (2021) explains the dimensions as follows. A cohesive classroom is characterised by emotional bonding, supportiveness and interpersonal boundaries that lead to mutual respect and appreciation. A flexible classroom requires lecturers to show leadership by inviting student input and being willing to respond to it, using appropriate measures of discipline by encouraging restorative behaviour and being open to negotiation. Classroom communication encompasses listening skills where the student and lecturer should be able to listen attentively to one another. To foster a classroom conducive for good understanding by the students, lecturers should be very clear and consistent in their verbal and non-verbal communication. Self-disclosure relates to students and lecturers feeling at ease to express their feelings, likes and dislikes to enable better mutual understanding.
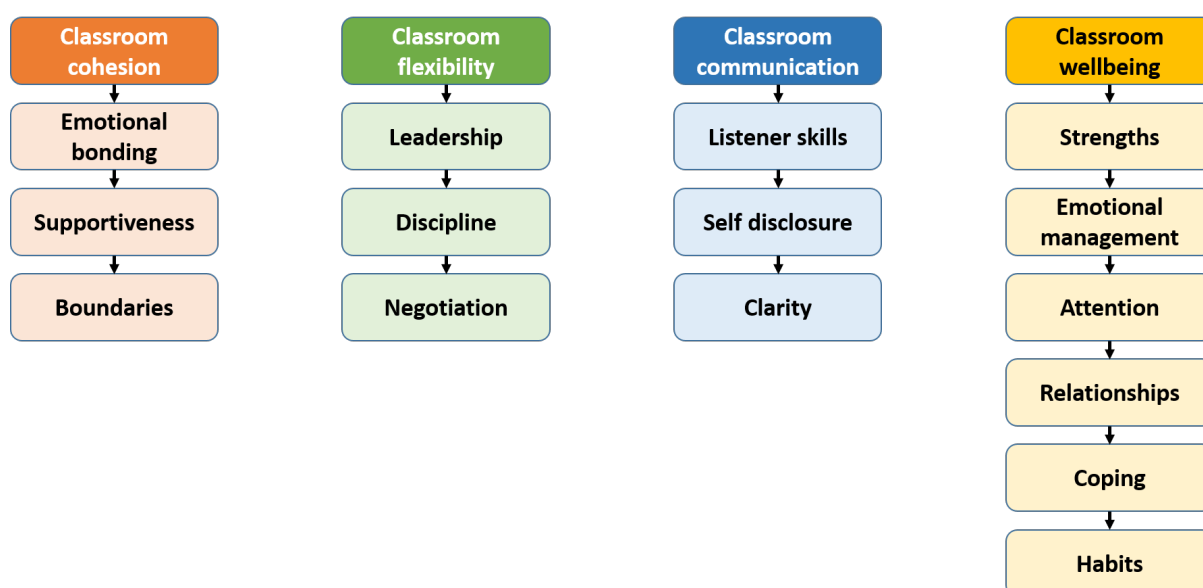
Classroom cohesion	Classroom flexibility	Classroom communication	Classroom wellbeing
Emotional bonding	Leadership	Listener skills	Strengths
Supportiveness	Discipline	Self disclosure	Emotional management
Boundaries	Negotiation	Clarity	Attention
			Relationships
			Coping
			Habits

Exhibit 1. *The Flourishing Classroom Systems Model (Allison et al., 2021)*

With the wellbeing dimension six additional sub-elements are introduced to the model, i.e., strengths, emotion management, attention, relationships, coping, and goals. With strengths is meant that lecturers' and students' talents are recognised, used, and developed to achieve a common purpose. Lecturers and students should manage their emotions effectively to collectively improve the emotions of the class. Attention should be focused on the present to increase happiness. The ability to develop and sustain meaningful relationships provides a sense of meaning and social connectedness and can be fostered in a classroom. Coping is an important feature assisting a student to manage life's demands and being resilient. A vital pathway to wellbeing is the progressing towards goals. Goal setting is therefore vital, followed by motivation, perseverance and, mastery.

The FCSM provides a valuable method to address the data science classroom as a system and assists in making its components more visible with the purpose to cultivate collective flourishing.

3| Critical systems thinking in education: An empirical demonstration

3.1| Purpose

The purpose of this study is to investigate to which extent an existing holistic instructional design matches the FCSM implicitly, to provide guidance to explicitly implement the FCSM in data science classes. This study focuses on the affected students and their needs within the context of the FCSM.

Given that the researcher wants to understand the wide range of personal meanings that students assign to their current experience of statistics and how they think it can be improved, an interpretive paradigm was utilised.

3.2| Participants

Undergraduate students registered at a South African university for a preparatory statistics module was the target population. The survey was completed voluntarily by 284 students, of which 81%

were black, 6% mixed race, 2% Indian students, and 11% white, which corresponds to this university's racial composition. The respondents (74%) were mainly females, which constitutes a true reflection of the course's gender distribution.

3.3| Data collection

Online written interviews were used since these are completely anonymous, thereby enabling students to voice their opinions, without having to fear victimisation.

The students were asked two open-ended questions: "I would enjoy statistics more if..." and "I would perform better in statistics if..."

The responses were coded, and themes were matched with those of FCSM as presented in Exhibit 1.

3.4| Demonstration of SIPP in teaching data science

To obtain initial insight on how to improve the instructional design of data science modules, a conventional interpretive study was done first, as explained in Coetzee (2021). The qualitative study triggered responses from students that address a wide range of topics such as content of modules, how it is presented, what the lecturer should be like, and students' personal shortcomings.

In this study the data is revisited to determine if better insight can be obtained by making use of the systems approach, SIPP.

For this study, the system is defined as the teaching of data science modules to students.

SIPP states that a system should have a shared purpose. The common purpose of the system is to empower the students with much needed data science skills while promoting their wellbeing. A graduate suffering from depression, lacking motivation or exhibiting a negative attitude will be indicative of a learning environment that has not fostered a culture of wellbeing.

Students find themselves in an environment that is interdependent – they are influenced by the content of the module, the manner it is presented to them, and interactions with fellow students. In turn, they themselves have an impact on how the lecturer reacts and how fellow students respond. The classroom is dynamic, since one action can create a whole array of actions. Resources include the students' time, the lecturer's time, and material of the module. The stakeholders whose perspectives need to be regarded, are the students and the lecturer.

With respect to SIPP's epistemological assumption, we can say that the data science teaching environment cannot be fully comprehended from one perspective only. Each student comes to class with a different perspective, whereas the lecturer has a different perspective. These parties meet in class, where the lecturer must facilitate the learning of the subject matter in such a way that the students will be able to both relate to and internalise it. In terms of the political assumption, the lecturer as well as the students' perspectives should be heard. Both parties have rights, but also responsibilities. For instance, a student has the right to good study material and an engaging learning experience but has the responsibility to study and hand in assignments on time, whereas the lecturer has the right to be treated with respect but has the responsibility to treat students with respect and design the learning experience so that students can get the maximum benefit from it. Regarding the ethical assumption, wellbeing in this demonstration should consider what is collectively optimal for both the lecturer and the students. One party should not benefit while the other party suffers.

The notion of inter-being reminds us that the broader systems (social as well as non-social) that affect the lecturer and student need to be considered. In our current environment it can be

influences such as COVID-19 restrictions, the effect of poverty and the collapse of support systems such as electricity and water supply in South Africa.

3.5| Demonstration of FCSM in teaching data science

The topics covered by the FCSM will be used to organise the students' comments on the two questions "*I would enjoy statistics more if...*" and "*I would perform better in statistics if...*" using directed content analysis. Table 1 provides examples of the comments received and indicate which component of the FCSM it addresses.

We will proceed to indicate how each of the items in the FCSM were addressed in the students' comments and the researcher will add her reflections.

3.5.1| Classroom cohesion

Here we were interested to see if topics emerged from the students' comments relating to student-lecturer and student-student bonding and support, as well as interpersonal boundaries. Some of the comments received can be seen in Exhibit 2 and the coding of the comments are provided in the Appendix.

Exhibit 2. Examples of comments received from students and how they address classroom cohesion

Comment (participant number)	Addresses
"classes include some fun and laughs" (245)	Classroom cohesion: bonding
"there were more fun activities included in the work" (001)	Classroom cohesion: bonding
"there is more interaction." (234)	Classroom cohesion: bonding
"SI leaders are present in every class to help struggling students." (278)	Classroom cohesion: support
"we work in groups more often" (36)	Classroom cohesion: support
I had a good lecturer who was patient enough to help me understand." (107)	Classroom cohesion: support
"they change the lecturer" (161)	Classroom cohesion: boundaries

Emotional bonding

They indicated that they had a need for the lecturer to be friendly, patient, and funny and they would like to interact more with the lecturer (e.g., participants 245, 001, 234). One student

mentioned the need that the class should pray together. They didn't address the need to have more emotional bonds with fellow students.

Supportiveness

Students mentioned that they needed more peer assistance and would like to have access to a student instructor more often (e.g., #278). Some suggested that working in groups would be of great help (#36). They need a patient lecturer who can help them understand their work (#107).

Boundaries

Some students suggested that the lecturer should be replaced, showing a lack of respect for the lecturer which may be indicative of an absent boundary (#161."

Cohesion: Reflection on results

Students indicated that classroom cohesion is important to them. They want a lecturer who is not distant but creates a positive atmosphere for learning and thereby guides students to experience the feeling of belonging in the class.   Students want support, especially from peer mentors. Boundaries should be set to encourage mutual respect.

Cohesion: Proposed guidelines

The lecturer should create a classroom where feelings of closeness and caring is fostered. Being friendly, creating fun moments and interaction opportunities, all within a context of mutual respect, can assist in attaining this.

3.5.2| Classroom flexibility

Next, students' comments were investigated to see if topics relating to adaptability to students' needs had emerged. Exhibit 2 contains some of the responses obtained and the coding of the comments are provided in the Appendix.

Exhibit 2. Examples of comments received from students and how they address classroom flexibility

Comment (participant number)	Addresses
" it was related to what I will be doing in future." (274)	Classroom flexibility: Leadership & negotiation
"we didn't have a group assignment." (253)	Classroom flexibility: Leadership & negotiation
"there's more class tests and mini-assignments, rather than a big exam." (002)	Classroom flexibility: Leadership & negotiation
"we did not write on a Saturday, after I wrote demanding subjects the day before. (153)	Classroom flexibility: Leadership & negotiation
"is more practical (on computers, etc.)" (005)	Classroom flexibility: Leadership & negotiation
"more videos of each study unit were given." (257)	Classroom flexibility: Leadership & negotiation
"it has less calculations and more theory" (040)	Classroom flexibility: Leadership & negotiation
"I attend every class and SI" (191)	Classroom flexibility: Discipline

Leadership

Leadership supposes that a lecturer will ask for students about input on activity and take that into consideration. From the comments received it seemed as though there were many issues

that the students would like addressed, such as understanding better how the module is related to their future careers (#274), the format (participants 253 and 002) and time of assessments (#153), if it was more practical (#005), more visual resources were provided (#257) and the number of formulas, calculations and interpretations (#040).

Negotiation

Since little leadership was shown, there was not much room for negotiation. Students indicated the need to discuss the type of assessments that were required from them, as well as the timing of the assessments. They had differing opinions on how theory, calculations and interpretations should be incorporated in assessments.

Discipline

Students indicated that they would perform better if they had attended more classes. This may indicate that the lecturer struggles to maintain this discipline among the students.

Flexibility: Reflection on results

Negotiation is difficult if it is not done in an environment where there is a visionary leader. The lecturer should be such a leader who knows where the students should be heading, and willing to negotiate on issues that will remove obstacles for students to ensure that they attain the goal. This should all take place within a disciplined setting. For instance, the lecturer may use the students' inputs and create a wider range of assessments, including something like a project that enables open book assessment. The lecturer can liaise with colleagues to ensure that different modules' assessments are not too close to one another.

Flexibility: Proposed guidelines

The lecturer should be sensitive for valid requests and willing to negotiate. However, the lecturer should be the leader who cleverly guides the students toward internalising the learning material. A lecturer who can create a flexible classroom by succeeding in taking the lead, being open to negotiation while ensuring a well-disciplined environment, will be able to successfully steer the students towards the common goal.

3.5.3| Classroom communication

Communication includes listener skills, self-disclosure, and clarity. See Exhibit 3 for a sample of the students' comments and the Appendix for the codes.

Exhibit 3. Examples of comments received from students and how they address classroom communication

Comment (participant number)	Addresses
" I listen to what the lecturer is saying so I can understand better to perform better." (255)	Classroom communication: Listener skills
" I ask questions during lecturing when I don't understand." (235)	Classroom communication: Self-disclosure
"the lecturer can be more interesting." (217)	Classroom communication: self-disclosure
"the information is clearer explained and more background is given." (273)	Classroom communication: Clarity
"the lecturer is able to explain the complex information better." (246)	Classroom communication: Clarity
"I could hear my lecturer. She should be slower." (275)	Classroom communication: Clarity

Comment (participant number)	Addresses
" it is taught in African language/ my mother tongue because it will be more easy and fun." (177)	Classroom communication: Clarity

Listener skills

Students indicated that they would understand and perform better if they listened to what the lecturer was saying (#255).

Self-disclosure

#235 indicated that he/she should ask questions if he/she doesn't understand the work. In a way, this can be seen as self-disclosure since the student is making him/herself vulnerable in front of the class by implicitly admitting having a problem to understand and asking for more explanation. A few students indicated that they would like it if the lecturer was more interesting, e.g., #217. While it is not quite clear what was meant, it may mean that they would like to know more about the lecturer's interests, hobbies, and other things other than only the module content.

Clarity

Students raised a lot of concern in this regard. Many indicated that the lecturer should explain better (#273 and 246), explain by using examples, should speak audible explain slower so that students can follow (#275) and should explain thoroughly (#273). One student mentioned that it would help a lot if he could receive the instruction in his mother language (#177).

Communication: Reflection on results

Many of the comments received addressed classroom communication. Without clear communication, understanding of a topic like statistics is very difficult. Learning takes place through effective communication. Where communication is sub-optimal, learning will be sub-optimal as well. It is essential that there will be clarity to ensure that students understand the work. On the other hand, students should also be able to communicate clearly. For instance, if a student doesn't understand something, he must have the ability to articulate his question in such a way that the lecturer can understand it and address it appropriately. A very important part of communication is the ability to listen. Students need to listen attentively. It is usually easier to listen and take in when one is actively involved, e.g., by taking notes while listening or making a summary while reading. Self-disclosure by the lecturer may prove rewarding, e.g., by discussing experiences, thoughts, opinions, and feelings. This fosters an environment for better mutual understanding and openness.

Communication: Proposed guidelines

Clarity should be present in terms of the "running" of the module, like communicating the schedule, deadlines, what is expected for an assessment and so on. It is essential that the explaining of the subject matter should also be clear, whether it is during a face-to-face class session, a slide show, written study material or a video. Students should be encouraged to ask questions. For those who may not be comfortable to ask in a class, other opportunities should be created for instance on a forum on the learning management system, or via a WhatsApp message. A lecturer should create learning opportunities where students are encouraged to listen more attentively, e.g., by asking them to make a summary while listening to the lecture.

A class where the lecturer and students are willing to disclose something of themselves should be fostered by the lecturer setting the example.

3.5.4| Classroom wellbeing

Most of the items of classroom wellbeing were addressed by the students, indicating that they identified it (without explicitly being aware of it) as crucial for the enjoyment and performance in the module. Exhibit 5 contains some of their accounts and the Appendix contains the codes.

Exhibit 5. Examples of comments received from students and how they address classroom wellbeing

Comment (participant number)	Addresses
"I was good at maths." (13)	Classroom wellbeing: strengths
"I enjoyed working with numbers." (94)	Classroom wellbeing: strengths
"I was a genius." (108)	Classroom wellbeing: strengths
"the atmosphere isn't dull even if it is stats.' (254)	Classroom wellbeing: emotional management
"my lecture doesn't become emotional when we don't understand in class." (275)	Classroom wellbeing: emotional management
"I had a positive attitude." (216)	Classroom wellbeing: emotional management
"more examples are produced with the content, as my understanding is built on practicals, doing it." 044)	Classroom wellbeing: attention
"it had more colour and crosswords. Fun activities that make you looking forward. (046)	Classroom wellbeing: attention: attention
"there are supplemental videos to help me understand the content." (137)	Classroom wellbeing: attention: attention
"the textbook had pictures and less complicated formulas." (048)	Classroom wellbeing: attention: attention
"it was done on a computer from 1st year." (253)	Classroom wellbeing: attention: attention
it was relating to my field of work or degree." (180)	Classroom wellbeing: attention: attention
"the lecturer was my mother." (240)	Classroom wellbeing: attention: relationship
"I keep up with my lecturer and the work she is doing." (265)	Classroom wellbeing: coping
"I don't miss any lectures and start preparing in time." (239)	Classroom wellbeing: coping
"I did more exercises in my free time." (236)	Classroom wellbeing
I stop procrastinating and focus more." (219)	Classroom wellbeing: coping
"I can manage my time better to be able with investing more time in stats." (000)	Classroom wellbeing: coping
" I study in time." (104)	Classroom wellbeing: goals & habits
"I work with my time better." (030)	Classroom wellbeing: goals & habits

Strengths

From their comments, it is evident that students felt that their weaknesses were highlighted, rather than their strengths. They indicated that they wish they had better mathematical abilities (#13), enjoyed working with numbers (#94) or be a genius (#108).

Emotional management

Lecturer's emotions have a significant impact on the classroom's emotional climate. Students complained that the classroom's atmosphere was dull (#254), implicitly indicating that the lecturer probably wasn't very cheerful and enthusiastic. Students also complained that a lecturer should not get emotional if the students don't understand the work (#275). Some students acknowledged that they had to work on their own negative attitudes toward the module and the lecturer (#216).

Attention

Students indicated that active learning experiences like doing practical exercises (#044) incorporating fun and games (#046), working on a computer (#253, making more use of visual aids, videos, and colourful slides with pictures (#137 and 048) would assist them to pay better attention and be more present-focused. They would also find it much more interesting if it related better to their field of study and they could see the benefit of studying statistics (#180).

Relationships

Very little mention was made of relationships. One student said he wished the lecturer was his mother, indicating that he viewed the lecturer in a very positive manner (#240).

Coping

Some indicated that they struggle to cope with keeping up with the lecturer in class (#265). Many students indicated that they struggled to cope and attributed it to their lack of time management skills (#000 and 239, their lack of self-discipline to work harder and practise more (#236), and their tendency to procrastinate (#219).

Goals and habits

From their responses that indicate a lack of time management (#104 and 30), most students don't set regular attainable goals for themselves in terms of their studies, but rather wait until a deadline is close before they start working.

Wellbeing: Reflection on results

No mention was made that indicated that the lecturer recognised and developed students' strengths. The comments rather showed that the students were very aware of their weaknesses in terms of their mathematical skills.

A lecturer should never show emotional outbursts. Likewise, students should not be allowed to display disruptive emotions. Poor emotional management is detrimental for a good relationship between the lecturer and students, because it undermines mutual respect. Having the ability to manage one's emotions is a very important quality to possess when entering the workplace. When a lecturer portrays it and guides students to develop it, a valuable skill is taught.

By putting in some effort to make statistics more colourful and entertaining may go a long way to make the experience more positive for students and thereby holding their attention for longer. Likewise, the lecturer should incorporate more activities in the class that involves the student, since an active student is more attentive.

While little mention was made explicitly about interpersonal relationships between student and lecturer, or among students, the need was implied by the comments on emotional bonding and

support. Without emotional bonding and mutual support there can be no relationship. It is a big challenge for a lecturer to create a space where relationship can be built in an online environment or in a limited face-to-face contact situation.

It is essential for students to learn not to procrastinate (especially in modules where they feel challenged), but to learn to manage their time effectively. By practising the discipline to work diligently on a regular basis rather than waiting for deadlines, students will learn the essential skill to cope irrespective of the workload, which is a much-needed skill in the fast and highly demanding world we find ourselves in.

It may be a good idea for lecturers to ask their students to set daily goals for themselves and thereby teaching them this useful habit which would help them to cope better with their studies, and life in general.

Wellbeing: Proposed guidelines

Addressing students' strengths should help to build their confidence and enable them to perform better in the module. To foster classroom wellbeing, a lecturer should enhance students' strengths through building their confidence by slowly introducing them to the concepts and giving them simple assignments that they can easily accomplish. As their confidence grows one can move to more difficult subject matter.

Lecturers should set the example by managing their emotions and encourage the students to do the same.

Try to make the learning experience as positive as possible by incorporating fun, engaging activities, using creative ways of conveying information and ensuring that students understand the relevance of statistics to their field should help students to be more attentive.

Put in effort to build positive relationships with students. If students feel positive toward a lecturer, they tend to feel more positive toward the subject as well.

Encourage students to set daily goals and learn time management skills, e.g., by incorporating a time management course in their curriculum.

4| Discussion

By making use of the FCSM model we are able to arrange the wide variety of students' comments in a meaningful manner that provide us with ideas on where and how to address classroom flourishing.

The two questions asked to the students were vague – they had to complete the two statements "I will enjoy statistics more if..." and "I will perform better in statistics if..." There was nothing in the questions that directed them to think in terms of classroom cohesion, communication, flexibility, or wellbeing, yet many of their comments addressed these dimensions of the classroom flourishing model. While Coetzee (2021) was able to extract meaningful themes when using undirected content analysis, the use of the FCSM to guide the directed content analysis was useful since it highlighted the need to take classroom flourishing into consideration when designing the learning experience. The results inform us about the 'social world' of the student in the classroom context, how they perceive it and how they would like it to improve.

However, if we apply the critical awareness commitment of CST, we need to scrutinise our findings. While the FCSM provides a useful guideline to understand the SW of students, it does not encompass their whole SW. It does not address issues like the effect of social distancing due to the pandemic, their living environment, their family, their friends, their experience of online learning, or the effect of social media. These issues play a role, e.g., Seun, Ayodotun, Atanda, and Gilbert (2021) reports that the pandemic caused loneliness, depression, and stress that affect students' wellbeing

For this study only students' perspectives were used, but it can be enhanced by receiving inputs from lecturers, practitioners, and life coaches.

5| Conclusion

The insight obtained provides universities with useful guidance as to what to focus on to improve the instruction of modules teaching data science.

To move toward the maximum development of students' potential, the proposed guidelines should be implemented, and more research should be done to understand the dynamics of the system better to advise on further improvements to the instructional design.

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7| **Appendix**

Exhibit 6. Enjoyment codes, their frequencies and the FCSM dimensions they belong to

Enjoyment code	Frequency	FCSM Dimension	FCDM Subdimension
lecturer replaced: desired	4	Cohesion	Boundaries
fun: desired	4	Cohesion	Emotional bonding
help from peer: desired	5	Cohesion	Support
incentives: desired	4	Cohesion	Support
private lessons: desired	1	Cohesion	Support
lecturer slow-down: desired	1	Communication	Clarity
lecturer communication: desired	6	Communication	Clarity
good lecturer: desired	1	Communication	Clarity
understanding: desired	12	Communication	Clarity&Listener skills
communication: desired	1	Communication	Clarity&Listener skills
ask to understand: desired	2	Communication	Self-disclosure&Clarity
interesting lecturer: desired	1	Communication	Self-disclosure&Clarity
attend classes: desired	5	Flexibility	Discipline
challenges: desired	2	Flexibility	Leadership
assessments: different mix desired	10	Flexibility	Leadership&Negotiation
relevance: desired	10	Flexibility	Leadership&Negotiation
visuals: desired	10	Flexibility	Leadership&Negotiation
class times: change desired	4	Flexibility	Leadership&Negotiation
computer work: desired	1	Flexibility	Leadership&Negotiation
previous papers: desired	5	Flexibility	Leadership&Negotiation
complicatedness: unwanted	4	Flexibility	Leadership&Negotiation
formulas: unwanted	2	Flexibility	Leadership&Negotiation
interpreting: unwanted	2	Flexibility	Leadership&Negotiation
statistics: unwanted	2	Flexibility	Leadership&Negotiation
workload: reduced	2	Flexibility	Leadership&Negotiation
contact sessions: unwanted	1	Flexibility	Leadership&Negotiation
exam timetable change: desired	1	Flexibility	Leadership&Negotiation
group work: desired	1	Flexibility	Leadership&Negotiation
group work: unwanted	1	Flexibility	Leadership&Negotiation
memos: desired	1	Flexibility	Leadership&Negotiation

Enjoyment code	Frequency	FCSM Dimension	FCDM Subdimension
more resources: desired	1	Flexibility	Leadership&Negotiation
open book assessment: desired	1	Flexibility	Leadership&Negotiation
steps for calculations: desired	1	Flexibility	Leadership&Negotiation
theory: unwanted	1	Flexibility	Leadership&Negotiation
positive attitude: desired	6	Wellbeing	Emotional management
already enjoy: content	6	Wellbeing	Emotional management
harder work: desired	2	Wellbeing	Habits
time management: desired	3	Wellbeing	Habits&Coping
lecturer approachable: desired	3	Wellbeing	Relationships
student good at maths: desired	7	Wellbeing	Strengths
better performance: desired	4	Wellbeing	Strengths
active learning: desired	9	Wellbeing	Attention

Exhibit 7. Performance, their frequencies and the FCSM dimensions they belong to

Performance code	Freq	FCSM Dimension	Subdimension
dull atmosphere: unwanted	1	Cohesion	Emotional bonding
active learning: desired	4	Cohesion	Emotional bonding
fun: desired	1	Cohesion	Emotional bonding
interaction: desired	1	Cohesion	Emotional bonding
help from peers: desired	5	Cohesion	Support
better accommodation: desired	3	Cohesion	Support
lecturer communication: desired	6	Communication	Clarity
understanding: desired	5	Communication	Clarity&Listener skills
ask to understand: desired	2	Communication	Self-disclosure&Clarity
attend classes: desired	4	Flexibility	Discipline
assessments: different mix desired	5	Flexibility	Leadership&Negotiation
previous papers: desired	4	Flexibility	Leadership&Negotiation
computer-based: desired	3	Flexibility	Leadership&Negotiation
more resources: desired	3	Flexibility	Leadership&Negotiation
assessments: more formative desired	2	Flexibility	Leadership&Negotiation
interpreting: unwanted	2	Flexibility	Leadership&Negotiation
relevance: desired	2	Flexibility	Leadership&Negotiation
visuals: desired	2	Flexibility	Leadership&Negotiation
calculations: unwanted	1	Flexibility	Leadership&Negotiation
easier assessments: desired	1	Flexibility	Leadership&Negotiation
formulae: unwanted	1	Flexibility	Leadership&Negotiation
group work: unwanted	1	Flexibility	Leadership&Negotiation
statistics: unwanted	1	Flexibility	Leadership&Negotiation
workload: reduced	1	Flexibility	Leadership&Negotiation
listen attentively: desired	1	Wellbeing	Attention
positive attitude: desired	5	Wellbeing	Emotional management
patient lecturer: desired	1	Wellbeing	Emotional management

Performance code	Freq	FCSM Dimension	Subdimension
harder work: desired	25	Wellbeing	Habits
practice more: desired	11	Wellbeing	Habits
time management: desired	23	Wellbeing	Habits&Coping
procrastinating: unwanted	2	Wellbeing	Habits&Coping
student good at maths: desired	10	Wellbeing	Strengths
better memory: desired	1	Wellbeing	Strengths
presented in African language: desired	1	Wellbeing	Strengths
stupid mistakes: unwanted	1	Wellbeing	Strengths