The Art of Teaching Professional Practice: An Action Research Methodology Inspired by Ulrich's Systems Concepts

Suné van der Linde1 · Roelien Goede1

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Abstract
Learning the art of any professional practice like engineering design or computer programming is a challenge for students and adds to the complexity of teaching such a technical discipline. Institutional regulations, along with industry expectations, increase the burden on the educator to develop a successful instructional environment. Critical systems thinking provides practitioners, in general, with a framework for understanding interrelation and complexities in a variety of problem situations. The art of systems thinking requires discourse on both the interdependencies, and multiple perspectives present in a problem situation. However, little guidance exists for educators in applying the concepts of critical systems thinking in their everyday practice of teaching a professional practice module at university level. This paper suggests a methodology based on action research and critical systems thinking concepts, to incorporate the art of systems thinking in the teaching of a professional practice module. The phases of action research are described from the critical systems perspective of Ulrich, in order to provide guidelines for an educator to embrace the complexity of professional practice education. Programming is used as a demonstration of the proposed methodology. The methodology incorporates systems thinking aspects such as the totality of conditioned realities, boundary critique, and acting as a witness sensitive to polemical argumentation on behalf of the affected. It demonstrates how Ulrich’s approach involves - and respects - all stakeholders in a system and guides the individual educator to excel in teaching a professional practice module. By making a conscious effort to listen to the affected and to incorporate as many conditioned realities as possible, the educator should be able to improve student engagement, resulting in better skills. We provide a demonstration of the art of teaching a professional practice module methodology which enables the educator to develop the programming skills of students in a complex environment.

Keywords The art of teaching · critical systems thinking · boundary critique · polemical argumentation.
Introduction

High level professional practice, whether it is architecture design, engineering design, surgery or computer programming is more than just a skill, it’s an art: an art that many practitioners developed themselves. This paper provides a methodology for teaching in disciplines which requires such a high level of considered application of skill, that it becomes an art. Although computer programming is used to inform the study, the reader need not understand the technicalities thereof to use the proposed methodology in their own discipline. Studies about how students learn professional practice are endless and it has been recorded many times that learning a professional practice is a challenge for students (Bosse and Gerosa 2017; Daley 2000; Williams 2001). Educators use a variety of teaching approaches in order to address challenges faced when teaching a professional practice such as self-directed learning (Davenport 2018), reflection (Paterson and Chapman 2013), and project based learning (Fernandes 2014). These approaches, in our opinion, are not sensitive enough to the complexities of the wider teaching environment including the personal reality of each student. We support the argument of Gergen and Gill (2020) that teaching goes beyond the “imparting of knowledge and skills”, (Gergen and Gill 2020:2). Educators in professional practice modules have a need to use their own experience, combined with theoretical approaches, to develop an effective instructional design (Watkins and Mortimore 1999) which facilitates the development of the whole person. To this end, action research is often used by educators to develop and refine their instructional design in an iterative manner, guided by theoretical insights of published research (Manfra 2019; Putman and Rock 2016). Our goal is to supplement the phases of action research with concepts of critical systems thinking, to enable educators to manage the complexity in their practice of developing the potential of their students. Developing the individual to their fullest potential is the description of individual emancipation provided by Flood and Jackson (1991), pioneers in critical systems thinking, which is one of the main goals of critical systems thinking. From our critical systems perspective, we view this development as reaching beyond the academic scope of a specific module. Within the realm of critical systems thinking, we propose the use of the concepts of Ulrich (1983), since his focus on conditioned realities and sensitivity to the interests of the affected, makes his work suitable for meeting the needs of the educator. Our focus is on the underlying concepts of his work on critical systems heuristics in terms of articulation of different perspectives, resources and environment of a wider system as well as describing boundaries between the (I) resources and environment and (II) the involved and the affected of the systems. Furthermore, Ulrich’s utilisation of the idea of polemical reasoning, which gives the affected a voice without the condition for rational argumentation, fits the position of the student.

The flow of the paper is guided by the FMA Model developed by Checkland and Holwell (1998), applied in Fig. 1. They argue that any research project is situated within a framework of ideas (F), applies a methodology (M), in order to investigate an area of concern (A). The aim of our paper is to suggest a methodology (section three) as the main contribution, informed by framework of ideas presented in section two (critical systems thinking in context of programming education and action research), to be applied in the area of education. We demonstrate the application of the suggested methodology in the instructional design of a second-year programming module at a university in South Africa.
The next section addresses critical systems thinking in the context of professional practice education and action research.

**Critical Systems Thinking in context of professional practice Education and Action research**

Our discussion of the framework of ideas begins with a brief discussion of programming education, focused on the challenges thereof. Each type of professional practice has its own unique combination of theoretical knowledge and skills required in the application thereof. As demonstration we focus on the specific nature of computer programming. The aim of the discussion is to provide a background to only the specific aspects of programming education required for the reader to understand the demonstration of our suggested methodology, which is presented in section three. Since our methodology is an enhancement of action research, we follow the discussion of programming education with a brief account of action research. The main component of our framework of ideas is critical systems thinking concepts as described by Werner Ulrich, which we present after the section on action research in anticipation of our suggested methodology.

**Learning a professional practice such as programming**

In his renowned series ‘The art of computer programming’, Donald Knugh presents computer programming as both a skill and an art (Knuth 1968). This can be said of engineering, architecture, and many other areas of professional practice. Learning a professional practice often focus on core structural elements and then the practicing of the elements as skills. As an example, learning to program focuses on the core of algorithm development, which consists of identifying steps to solve the perceived problem and translating those steps into a computer programming language (Giannakopoulos 2017). Learning to program is a challenge for students (Govender et al. 2014; Matthews et al. 2012; Robins et al. 2003) and there are various reasons why students struggle in programming modules which can be
translated to other disciplines as well; whether it is poorly constructed mental models (Ma et al. 2008), problem-solving skills (Govender et al. 2014; Havenga et al. 2013; Saeli et al. 2011), insufficient prior [programming] experience (Govender 2010), ineffective learning styles (Raadt and Simon 2011) or students’ negative beliefs about their own [programming] ability (self-efficacy) (Govender et al. 2014; Kinnunen and Simon 2012). The same applies to other similar disciplines. Gergen and Gill (2020) writes that teaching strategies which applies rigorous individual testing strategies amplifies these negative emotions of students.

Discipline specific teaching approaches have been developed in many professional practice disciplines (Häfner et al. 2013; Hanks et al. 2011). Similarly, in our environment of teaching programming, several approaches were developed, such as structured programming, software development, small programming, language teaching, learning theory (Lau and Yuen 2009) and code reproduction or problem-solving (Pears et al. 2007). New teaching approaches usually come into existence when educators draw on their experiences and make a conscious effort to seek ways to address the difficulties experienced in their classrooms and enhance learning for the students (Watkins and Mortimore 1999). Drawing from our own experiences and passion of a combined 40 years of teaching and researching programming, we still do not fully understand the topic. What we have learnt is that reducing the strategy in terms of specific teaching approaches, does not solve our problems. Furthermore, we agree with Gergen and Gill (2020) that focus on students as consumers in many modern universities, inhibits both their learning and well-being. Our wider context in terms of availability of equipment, academic, social and technical support for students, limitations in terms of our environment such as industry expectations and university assessment policies, along with what sometimes seem interminable other factors, influences our success at a given time. We have learnt that we must develop our own strategy continuously, as every aspect of our teaching environment changes constantly, and we have to meet certain expectations from industry and adhere to university assessment policies. Action research provides us with an epistemological tool to learn while enabling us to fulfil our passion for the development of our students as complete human beings, who are able to take their place in industry and society.

**Action research**

Action research is a technique used by practitioners within a specific context, wherein they apply some sort of intervention experiment that is applicable to certain problems encountered (Baskerville 1999). Baskerville (1999) posits that AR enhances the understanding of a complex problem and that the ideal situation for AR is a social setting: one where the researcher involved has an expectation of possible benefits to themselves as well as the involved organization; where immediate application of the knowledge obtained is of importance to the researcher and where the research performed is a cyclical process in which theory and practice are integrated (Baskerville and Wood-Harper 1996). The phases in the AR cycle include diagnosis, action planning, evaluating and specifying learning, as given by Susman and Evered (1978). More information on these phases is provided in section three, in support of our proposed methodology. When AR is applied within an organization, the researcher is put in a “helping role” (Baskerville and Wood-Harper 1996). Using the knowledge gained during the AR cycle we are able to make an immediate difference to
the participants involved, and the cyclical process is guided by theory, which is applied to practice.

Our understanding of action research is shaped by the ideas of Checkland and Holwell (1998), in terms of FMA model we applied in the introduction (Fig. 1). When action research is conducted, changes in terms of the framework of ideas, methodology and area of concern can be expected as the research progresses. Changing the framework of ideas, methodology or area of concern - since the researcher gets too involved in the real world situation - is one of the most important principles of AR, which is often neglected in literature (Checkland and Holwell 1998). The AR process in human situations implies that the researcher, who has to declare their framework of ideas and methodology within a specific theme of interest, will then play the role of researcher, but also participant; will then work towards bringing about improvement in the social situation; and should then reflect on the framework of ideas and methodology based on the involvement phase. Refinement could be considered even at an earlier stage, in the process of thinking about the suitability of the framework of ideas and the methodology. Action research guides our process of reflective practice aimed at developing the potential of our students and ourselves.

Our aim in this paper is to articulate our methodology for discourse in the wider academic community in order to enhance understanding of the practices of teaching a professional practice within the boundaries of our system. We have learnt that every time we think that we have made progress in our understanding and achieved relative success, we realise how temporal our understanding is. In 2020, our understanding was influenced dramatically by world events such as the Covid-19 pandemic, which forced our efforts to online-teaching; and the Black Lives Matter movement which supported our constant consideration of the individual context of our students. We were reminded to widen our context and to increase the number of perspectives we consider when trying to understand the interdependencies of our problems. These two aspects of multiple perspectives and interdependencies resonate with the central ideas expressed by Werner Ulrich on Systemic Thinking as the “art of interconnected thinking” (Ulrich 2005a; Vester 2007).

**Aspects of Ulrich’s contribution to Critical Systems Thinking**

The aim of this section is to provide theoretical support for the systems thinking concepts, mostly developed by Ulrich (1983), which we use in our proposed methodology presented in section three. We begin our discussion with a short description of the relevant work of Churchman (1983), who had a strong influence on the work of Ulrich. We then continue with Ulrich’s interpretation of the multi-perspective characteristic of a system based on Kantian ideas. This view on the totality of conditioned realities naturally leads to boundary critique that determines who and what is part of the system, or not. The section concludes with a brief discussion of critical systems heuristics.

**The Systems Approach of Churchman**

In his seminal work of 1968, Churchman describes a system as “a set of parts coordinated to accomplish a set of goals” with five considerations to reflect upon when thinking about the system: (i) the total system’s objectives, to be used as performance measures of the system, which should never be compromised; (ii) the environment or the fixed constraints outside the control of the system’s management; (iii) the resources of the system or the means within, which the system uses to achieve its objectives; (iv) components or missions
of the systems which are the parts of the whole, each helping to achieve the overall objective; and finally (v) the management of the system, responsible for making the plans for the system within the context of the other considerations. In our discussion of Ulrich’s work, the boundary between the outside of the system (environment) and the other components inside the system is important. Ulrich (1983) refers to this distinction as Boundary I. The work of Churchman (1983) provides a foundation for rational thinking about the system, while Ulrich (1983) presents an alternative which is focused on critical discourse in terms of deceptions and fairness to both the involved and affected - as discussed later in the section.

The System

Ulrich (1983) extends the traditional ‘sum of the parts’ definition of a system in two ways. Firstly, he focuses on interdependencies and secondly, on multiple perspectives. His focus on multiple perspectives is grounded in a Kantian view. From this Kantian view, a system moves away from functionalistic systems views to a more holistic approach, where theoretical and/or practical judgements depend on the totality of conditioned realities (Ulrich 1983). A person constructs their own conditioned reality, which is influenced by personal beliefs, ideas and interests: this is said to be ideological (Ulrich and Reynolds 2010). Each person’s reality is different (conditioned) – each person is considered as looking through an ideological lens (Ulrich and Reynolds 2010; Ulrich 1983) writes that the systems idea strives towards the ideal of comprehensiveness and that the systems idea is the “… problematic but unavoidable notion of totality of relevant conditions – a totality we cannot possibly know, although we can and must nevertheless think it”. The number of conditioned views of each phenomenon are endless, and this makes it impossible to understand all conditioned viewpoints (Kant 1781). The only way to gain a better understanding of a system, is to discuss as many different lenses (conditioned realities) that people use as possible, in the situation (Ulrich and Reynolds 2010). A system, within this context, refers to a conceptual construct instead of a physical system (Ulrich and Reynolds 2010). Ulrich explains that Critique refers to a critical reflection, confronting your own conditioned reality first, before considering the conditions of others. Boundary judgements depict which empirical observations can be seen as less important, and which as relevant (Ulrich 2005b). The boundary critique is defined as “… a systematic reflective and discursive effort of handling boundary judgements critically, whereby ‘critically’ means both self-critical questioning one’s own claims and ‘thinking for oneself’ before adopting the claims of others” (Ulrich and Reynolds 2010). This is of special importance when the “boundary” is based on an established practice over many years. In our application we have to consider our own claims on assessment in context of the governance and student perspective very carefully as discussed later.

Boundary II: Involved and Affected

In order to determine the boundary of a system, it is important first to distinguish between the involved and the affected, polemical argumentation and the role of the witness. The involved refers to everyone involved in the planning process, such as the planner, the experts, the decision-makers and the witnesses of those to be served (Ulrich 1983). The affected refers to the individuals not involved, but who will be affected by the improved changes, without having any input into the planning process (Ulrich 1983). Comprehensiveness is synonymous with systems, which are dependent on quasi-transcendental reflection - also known as a critical reflection on sources of deception, and therefore the boundary judgements are so important (Ulrich 1983). Part of striving towards comprehensiveness includes quasi-metaphysical reflection, which involves subjective reflection about the con-
cerns of the affected living in the social reality that is in question (Ulrich 1983). Critical reflection is expected of the systems planner, but not from the witness; whereas the witness will deliver quasi-metaphysical reflection (Ulrich 1983). A witness is an individual who will represent the affected, in order to voice the concerns of affected individuals such as their feelings, concerns, suffering, and ways of living in the contested social reality (Ulrich 1983). A witness translates polemical argumentation, presenting the subjective views of the affected in a rational manner, in order to counter the advantage that the expert has, in terms of knowledge and expertise (Ulrich 1983). The witness needs to expose normative content of the expert, using quasi-metaphysical reflection rather than quasi-transcendental reflection (Ulrich 1983).

Ulrich refers to polemical argumentation by affected parties when they voice their concerns in a way that does not conform to the standards of rational argumentation. In ideal rational discourse models, such as the one developed by Habermas, it is assumed - or even a prerequisite - that the parties involved can deliver a cogent argument (Ulrich 1983). Cogent argumentation, also known as rational reasoning, requires deductive logic and empirical verification typically done by the expert (Ulrich 1983). This is impractical in a discourse where the strongest rational argument decides the outcome, since the expert is easily able to make rational arguments and the witness has to voice the concerns of the affected which has a certain or lack of competence (Ulrich 1983). A better approach would be to have criteria that do not rely on any special level of competence, and are rather solely focused on reason (Ulrich 1983: 301) writes: “Systems rationality depends upon critical (quasi-transcendental) reflection of the sources of deception contained in the inevitable lack of comprehensiveness of any systems map or design, given the necessity of a priori boundary judgements. Such reflection requires the capability to think and argue cogently according to the principle of reason, a capability that we can expect from the planner but that we do not want to require from the witnesses.” and later on page 301, “We need therefore to rely on the witness as the representatives of the affected, for making certain that the normative content of the planner’s maps and designs is brought to light”.

Polemical argumentation provides a platform for individual emancipation of the affected citizens, and it is the responsibility of the expert to ensure representation of the arguments of the affected inside the system even if the affected themselves are not capable thereof (Ulrich 1983). He promotes understanding of the underlying meaning behind each viewpoint in order to improve understanding of the phenomenon (Ulrich 1983).

Boundary I critique, as discussed earlier, is a distinction between what belongs to the system, and what belong to the system’s environment (Ulrich 1983). Boundary critique is therefore a critical process of identifying the boundaries (I and II) and the normative claims (made by the planner) of the system, transparently. Boundary judgements are key to the boundary critique process of identifying the involved and affected as well as surfacing assumptions in a system (Ulrich 1983). Ulrich provides a methodology to practice boundary critique, called Critical Systems Heuristics.

Critical Systems Heuristics

Up to now we reflected on two of the components of the term Critical Systems Heuristics (CSH). Being ’critical’ is when one reflects on the underlying assumptions / deceptions of oneself and that of others, and of assumptions of methods used. The system is the unreachable totality of conditioned realities that guides us to understand as many perspectives as possible. The third term, ‘heuristics’ still requires some reflection. A simplistic summary
of the discussion provided by Ulrich (1983) is sufficient for our purpose. Heuristics guides discovery of the problem; Ulrich (1983) refers to “… the art of making ‘the problem’ the problem”. In the context of CSH, the discovery is focused on identifying the sources of deception. CSH provides a practical methodology with which to articulate various aspects of a system from multiple perspectives, while being aware of the normative content of boundary judgements.

Ulrich (1983) formulates a set of 12 questions based on the different boundary issues (Table 1), with the aim of making the judgements, which are relied upon in order to understand situations which are explicitly known to those involved and those affected (Ulrich and Reynolds 2010). The questions are to be considered in the ‘is’ and ‘ought to be’ modes. The first nine questions focus on the involved and the remaining three on the affected (Ulrich 1983). The core idea behind the 12 questions is to make the planner aware of boundary assumptions, and reflect upon those assumptions (Ulrich and Reynolds 2010; Churchman 1983) refers to this process of unfolding in order to achieve a whole systems view as “sweeping in” (Ulrich and Reynolds 2010).

These questions are incorporated in the phases of AR in the context of programming education in our suggested methodology, presented in the next section. From our discussion of Ulrich’s work we conclude that the planner has the responsibility to ensure transparency of the boundary judgements and to surface normative claims striving towards a whole systems view (Ulrich 1983). An objective whole systems view is not possible, but the planner should strive towards the totality of conditions for the system, trying to understand as many conditioned views as possible (Ulrich 1983), including the possible polemical views of the affected. One of our important challenges in our specific problem situation of teaching programming, is presence of boundary reflection but the lack of boundary discourse. Ulrich and

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**Table 1** The boundary categories and questions of CSH (Ulrich and Reynolds 2010)

| Sources of influence | Social roles (Stakeholders) | Specific concerns (Stakes) | Key problems (Stakeholding issues) | The involved |
|----------------------|-----------------------------|---------------------------|-----------------------------------|-------------|
| **Sources of motivation** | 1. Beneficiary: Who ought to be / is the intended beneficiary of the system (S)? | 2. Purpose: What ought to be / is the purpose of S? | 3. Measure of improvement: What ought to be / is the measure of improvement? | The involved |
| **Sources of control** | 4. Decision maker: Who ought to be / is in control of conditions of success of S? | 5. Resources: What conditions of success ought to be / are under the control of S? | 6. Decision environment: What conditions of success ought to be / are outside the control of the decision maker? | The involved |
| **Sources of knowledge** | 7. Expert: Who ought to be / is providing relevant knowledge and skills for S? | 8. Expertise: What ought to be / are relevant new knowledge and skills for S? | 9. Guarantor: What ought to be / are regarded as assurances of successful implementation? | The involved |
| **Sources of legitimacy** | 10. Witness: Who ought to be / is representing the interests of those negatively affected by, but not involved with, S? | 11. Emancipation: What ought to be / are the opportunities for the interests of those negatively affected to have expression and freedom from the worldview of S? | 12. Worldview: What space ought to be / is available for reconciling differing worldviews regarding S among those involved and affected? | The affected |
Reynolds (2010) distinguish between boundary reflection, i.e., personal self-critical reflection, and boundary discourse which is focused on discourse about the issues with others.

**Suggested methodology: The art of teaching a professional practice module**

For the past 30 years, as we tried every semester to be better programming educators, helping more students to develop their potential, we realised that similar to the ‘art of programming’ and the ‘art of systems thinking’, described above, we are practising ‘the art of teaching programming’. Our “art of teaching programming” can be generalised as “the art of teaching a professional practice module”, since the specific nature of computer programming is comparable to other professional practices. Before we present our suggested methodology, we describe the development thereof.

**Research methodology**

For at least the past 15 years we have purposefully developed our ideas into a methodology using action research, incorporating experience from many more years than that. Between the two researchers, we can roughly count 70 completed semesters of teaching various programming modules. As scholars in Information Systems and Computer Science, we used the core principles of critical research (Myers and Klein 2011), to guide our research. However, these principles are not limited to information systems research. The principles promote the work of a critical social scholar to guide intervention in a problem environment, aiming to achieve emancipation at both individual and society level. Contribution towards critical social theory scholarship is advocated by Myers and Klein (2011). Individual emancipation is one of the key principles of critical social research, which we view in terms of the development of the full potential of each individual student, using Ulrich’s systems concepts. As a result of improving the programming skills of graduates, we hope to improve the level of programming in industry, thereby improving some aspects of life for society in general. Industry has an expectation that students that exits university has obtained a certain skill set, and if we can improve the programming skills of students, we made a contribution to society. We do hope to make an explicit contribution to programming education literature and literature on the practise of critical systems thinking. Our methodology of action research required purposeful reflection and we have published articles on our learning from our students through experience. Since our context for development of the methodology is our own programming modules, our methodology is rooted in computer programming, however it may be reflected upon from different disciplinary perspectives.

We present our methodology in terms of a broad outline and a set of commitments, and finally, enriched version of action research.

**The art of teaching a professional practice module: broad outline**

One of the most important conclusions from our own effort is that one cannot prescribe a method to teach a professional practice module such as programming. We have been reflecting on our practises of teaching programming for many years and we still do not have
answers: but we have strategies. So, our methodology: the art of teaching a professional practice module is primarily a set of guidelines to incorporate the art of systems thinking into our practice of teaching the art of programming in the context of an ever-changing world.

Above all, the practice of the art of teaching a professional practice module is Learning, while doing with purpose, within a complex reality. This practice can be divided into 3 fundamentals: (1) Learning while doing; (2) doing with a purpose; and (3) within a complex reality. ‘Learning while doing’ promotes the explicit use of action research by the educator. ‘Doing with a purpose’ promotes the explicit use of CSH with emphasis on the involved and affected (including using proven teaching approaches). Finally, ‘within a complex reality’ promotes understanding of interdependencies and multiple perspectives resulting from practicing systems thinking from the Kantian perspective of totality of conditioned reality. When embracing the complexity becomes a characteristic of behaviour, there should be an overwhelming emphasis on relationship building. Authors, such as Gergen and Gill (2020) promotes the value of relationships in educational settings among all stakeholders.

The art of teaching a professional practice module: commitments

We have learnt that the following commitments, developed from the core concepts of Ulrich’s contribution to critical systems thinking, serves us well in our success as programming educators. The following commitments should be viewed in the “ought to” mode which are associated to aspirations.

1. Reflection on the objective of the module. Every module starts with a clear statement of intent. This is unfortunately often articulated as objective or the learning outcomes of a module that is expected from a student to pass. Our commitment encompasses this to include our personal commitment to relationship building with the students and industry. A personal objective may be inspired by the pedagogical motive of guiding another individual to independence or it may focus on the emancipation goal of developing each individual to their fullest potential as complete human beings. Inspired by Churchman and Ulrich we argue that this objective is the one that educators will not compromise on.

2. Continuous development of own expertise. CSH has a strong notion on what constitutes expertise. From our experience the educator should have full understanding of the module content. This requires the educator to become a life-long learner and to critical reflect on their own learning journey as well as their personal shortcomings in terms of technical knowledge of the discipline that teach.

3. Continuous self-reflection of teaching practice. Our assumption is that we and our students evolve all the time. We are committed to reviewing our actions continuously to adapt to the changing needs of the students and the changing regulations of our university. Our module content also has to change frequently to support the ever-changing needs of the information technology industry. In our practicing of CSH we are aware of our shortage of opportunity for discourse. As educators, we have periodic phases of redesign of modules and degree programmes where various stakeholders are consulted. We also reflect continuously on our practices without the luxury of having discourse with representatives of all the stakeholders. We encourage discourse among colleagues on matters causing deception. These are matters where individual perceptions lead to
diverse experience of reality. Gergen and Gill (2020) argue that one should change an education institution from the bottom up, which is what we hope [Kant’s third question] to achieve in our environment.

4. **Awareness of our complex environment.** Our own focus is mainly on second-year students, and we find that we can never assume specific prior knowledge: neither in terms of the collective group who complete the prerequisite module successfully, nor in terms of individual student readiness. We have to focus on individual development through relationship building. An annual reflection on the complexity of our environment in terms of university regulations enables us to identify trends, and to improve our instructional design proactively. An example of such an environmental change from our case work, is the alignment of different campuses in terms of performing the same summative assessment. Another example is the changing of the number of credits of a specific module in programming. By setting an example of the ethic of care, we are able to influence those around us.

5. **Passion and consideration for individual students.** Although our class sizes can be more than 500 students, we are committed to individual students. We are committed to the development of each student into an autonomous, self-directed, lifelong learner, who takes ownership of their own success. Within this context, we are committed to listening to the individual student who has the courage to visit our offices or send us an electronic message. Although our large class groups demand clear, complete communication on electronic platforms to minimise administrative queries, we know that the individual student who contacts us, gives us an opportunity to improve reality for that person. Our understanding of polemical argumentation ensures that we do not expect rational arguments (rational in terms of our own perspective) from individual students. From our experience, a student who visits our offices states a superficial reason for entering but hopes to solve an altogether different problem. Ulrich’s work reminds the lecturer to assume an attitude of consideration for the affected and of acting as a witness for the affected. This allows the lecturer to investigate their context, also in terms of deceptions, in order to develop an instructional design that has the development of their potential (individual emancipation) at heart. The lecturer should always consider that he/she holds a position of power in terms of decisions about students and should therefore consider the students in every decision.

6. **Awareness of the complete experience of our students.** The students bear the consequences of our selection of a teaching approach and our assessment strategy. Our module is only one of four or five modules taken in their degree programme each semester. If we are able to integrate their knowledge gained in different modules, we are maximizing their benefit from their study. We have a duty to influence our colleagues to ensure that all lecturers work together to achieve what is best for the stakeholders.

7. **Commitment to scholarly contribution.** By being committed to our own scholarly development and scholarly contribution we also serve the interests of the university and the wider community. From our scholarly discourse we improve our practices and learn new approaches that can be used to the benefit of our students.

We strive to practice these commitments in all aspects of our teaching practice.
The art of teaching a professional practice module: enhanced action research

We present our systemic methodology in terms of the phases of action research. We agree with Flood (2010) on the compatibility of action research and systems thinking: Systemic thinking is grounding for AR because it has the potential to “broaden action and deepen research” (Flood 2010) writes that “… action research carried out with a systemic perspective in mind promises to construct meaning that resonates strongly with our experiences within a profoundly systemic world. If systemic thinking delivers on this promise, then modern people may at last make sense of our existence on earth that we belong here, together, perhaps not in idyllic harmony, but at least with thoughtful tolerance”. AR is therefore suitable especially in a study that focuses on individual improvement within a wider context of complex interactions of different stakeholders.

Table 2 contains a description of the enhancement of each phase of AR in terms of CSH, with special application to teaching a professional practice module. Although the application is not restricted to teaching computer programming, it is rooted in our practices of teaching computer programming. The enhancement is given in terms of additional questions in our area of application (teaching a professional practice module), inspired by CSH (Table 1). The development of the questions is inspired by our stated commitments. These questions should be used as sample questions and educators using the art of teaching a professional practice should extend this list to cover their specific needs.

Action research has major phases for diagnosis, intervention and evaluation. The ought to / is modes of the questions in CSH should be used accordingly. Ulrich advises that the “ought to” mode is done first before the “is” to prevent the current situation from restricting creative solutions. However, we propose from our experience, discussed in the demonstration, that both the “ought to” and the “is” questions are answered as part of the diagnosis. Thus, we propose that the diagnosis phase becomes a hermeneutic interaction between the “ought to” and the “is” reflection on the CSH questions. The planner creates an ideal mapping of the situation and then positions the current mapping in context of the ideal mapping to develop a plan of action in the second AR phase.

Demonstration of “the art of teaching a professional practice module” in a programming module

As stated earlier, the purpose of this demonstration is to show how our methodology, the art of teaching a professional practice module, guided by action research and grounded in critical systems heuristics, can be used to guide the development potential of students.

Our reported study is at the North-West University in South Africa. The programming module used in our demonstration is called User Interface Programming, UIP. The first, second and fourth iteration concerns second-year students doing the UIP 2 module. During the second iteration we identified the need to improve the first-year module because we identified lack of prerequisite knowledge as a barrier to our students. The third iteration, therefore, involves the first-year module UIP1. We followed this same group of students into their second year (UIP2) during the fourth iteration. Since our focus is on the methodology, rather than on the results, the final two iterations are only discussed briefly.
Action Research Phase One: Diagnosis
The aim of the diagnosis phase is to understand the problem based on initial understanding and from previous iterations of the AR cycle.

Sources of motivation
CSH: 1. Who ought to be / is the intended beneficiary of the system (S)?

Reflective questions
What ought to be / is the overall motivation of our teaching practice?
Which groups ought to / do benefit from our teaching?
How do we ought to / currently teach the content to aid the development of each student into an autonomous, self-directed, lifelong learner, who takes ownership of their own success?
Who suffers when the module is not successful?
How do we ought to / currently teach the content to enhance the profile of the programme inside the university?
How do we ought to / currently teach the content to enhance the profile of the programme in industry?
How do we ought to / currently teach the content to enhance the profile of the programme for future / past students?
How do we ought to / currently make a scholarly contribution to benefit other educators and scholars?

Reflection based on commitments
Reflection on our own motivation, stimulates thought on our motivation for teaching in general and our motivation for teaching a specific module and including specific content in that module. By reflecting on both the “is” and “ought to” modes of the questions we are forced to reflect on the past and the justification for current practices. Focusing on the “ought to” mode motivates critical reflection of different opportunities. We reflect on the key aspect of our motivation which we will not compromise on. In our case, this is the development of the potential of the students, sensitive to individual contexts. The potential of the student is influenced by the requirements of industry. The commitment to self-reflection guides us to reconsider the question of beneficiaries frequently, not only from our own perspective, but also from the wider regulatory perspectives of the university and the degree programme. This reflection should not be limited by past restrictions. By focusing on the ideal state, guided by the “ought to” questions, the team focuses on the possibility of institutional change. In terms of our commitment to our complex environment, we also consider the needs of the information technology industry. Although we do not have the capacity to frequently study the needs of the industry, we are sensitive to their needs as discovered through periodic evaluations, studies by other universities and informal information from a variety of sources. Our commitment to the individual student extends our focus beyond the current student. A focus on past and future students is required to balance the direct needs of current students, driven by their immediate context. Our commitment to the total experience of the student focuses attention on their degree programme in total. From this perspective we consider the benefits to the stakeholders in the context of the dependencies among all modules in the programme. In terms of our final commitment to scholarly contribution, we aim to extend the benefit of our efforts beyond our own discipline in order to improve teaching in general.

CSH: 2. What ought to be / is the purpose of S?

Table 2 The art of teaching a professional practice module: enhanced action research

| Reflective questions | Reflection based on commitments |
|----------------------|---------------------------------|
| What ought to be / is the overall motivation of our teaching practice? | Reflection on our own motivation, stimulates thought on our motivation for teaching in general and our motivation for teaching a specific module and including specific content in that module. By reflecting on both the “is” and “ought to” modes of the questions we are forced to reflect on the past and the justification for current practices. Focusing on the “ought to” mode motivates critical reflection of different opportunities. We reflect on the key aspect of our motivation which we will not compromise on. In our case, this is the development of the potential of the students, sensitive to individual contexts. The potential of the student is influenced by the requirements of industry. The commitment to self-reflection guides us to reconsider the question of beneficiaries frequently, not only from our own perspective, but also from the wider regulatory perspectives of the university and the degree programme. This reflection should not be limited by past restrictions. By focusing on the ideal state, guided by the “ought to” questions, the team focuses on the possibility of institutional change. In terms of our commitment to our complex environment, we also consider the needs of the information technology industry. Although we do not have the capacity to frequently study the needs of the industry, we are sensitive to their needs as discovered through periodic evaluations, studies by other universities and informal information from a variety of sources. Our commitment to the individual student extends our focus beyond the current student. A focus on past and future students is required to balance the direct needs of current students, driven by their immediate context. Our commitment to the total experience of the student focuses attention on their degree programme in total. From this perspective we consider the benefits to the stakeholders in the context of the dependencies among all modules in the programme. In terms of our final commitment to scholarly contribution, we aim to extend the benefit of our efforts beyond our own discipline in order to improve teaching in general. |

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Table 2 (continued)

| Sources of control |
|-------------------|
| **CSH: 4. Who ought to be/is in control of conditions of success of S?** |

We need to reflect on the purpose of teaching programming from each of our commitments. In specifying various contexts within which to reflect, we are able to provide guidance for practitioners. Our commitment to self-reflection requires us to transcend our own perspective. Our commitment to our complex environment makes us aware of the different perspectives when we reflect on our purpose as educators. Our commitment to our individual student (past, future and present student) inspires communication with students on the purpose of our actions. In terms of the wider context of our students, the purpose of programming education goes beyond technical skills and aims to develop the student as a well-rounded graduate ready to make a contribution to society. Our scholarly commitment manifests not only in inspiring other teachers, but we also strive towards making a contribution to the scholarly community of programming as a discipline.
Table 2 (continued)

Action Research Phase One: Diagnosis
The aim of the diagnosis phase is to understand the problem based on initial understanding and from previous iterations of the AR cycle.

| Question                                                                 | Answer                                                                                          |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| How do we ought to / currently promote discourse among colleagues?       | As part of the diagnosis phase, we need to understand our mandate in context of our environment. We need to understand which aspects of module can be changed and what the consequences are, of our changes. Discourse with colleagues can widen our own understanding.    |
| What ought to be / is the role of the students in decisions?             | Although we are committed to our individual students, we are convinced that current students should not be in control of the purpose and measures of success of the module. However, communication is required to enhance their learning experience. From our experience, there is continuous tension between the conditions set for success from the lecturer’s perspective and those conditions set from faculty management. These include face-to-face time allocated on the timetable, practical laboratory time allocation and examination conditions. We also experience tensions in terms of practical implementation with industry partners. Due to financial and other constraints, it is not possible to change the application environment as frequently as suggested by some industry partners. We are committed to discourse to find workable solutions to the benefit of all beneficiaries identified in CSH: 1. |
| How do we ought to / currently communicate decisions to students?        |                                                                                                 |
| What ought to be / is the influence of university regulations on our decisions on matters including, but not limited to, assessment and credit-hours, teaching mode and lecturer time allocated? |                                                                                                 |
| Should the industry have more power in decision-making?                 |                                                                                                 |
| How do we ought to / currently involve industry in matters such as moderation and quality control. |                                                                                                 |

**CSH: 5. What conditions of success ought to be/are under the control of S?**

| Question                                                                 | Answer                                                                                          |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| How do we ought to / currently use our own resources optimally?          | In the original work of Ulrich (1983), this question concerns the components and the resources of the system. Our commitment to self-reflection guides us to constantly reconsider our allocation of resources. The boundary (I) between resources and environment is often vague and ever-changing from an educator’s perspective. As academics, we often experience conflicting demands on our personal resources, such as time and mental capacity. Our self-reflection should guide us to develop strategies to combine our effort to reach our goals. We need to make optimal use of administrative and other support provided by the faculty. Through constructive discourse with colleagues, we should be able to combine module design / assessment efforts to work more efficiently. Creative use of available resources might open opportunity for scholarly contribution and subsequent tension relief in terms of publication demands. |
| How do we ought to / currently update our own knowledge / expertise continuously? |                                                                                                 |
| How do we ought to / currently extend our available resources within the constraints of the university? |                                                                                                 |
| Which resources ought to be / are required in support of the students?  |                                                                                                 |
| How ought / are available resources used to benefit the total experience of the students? |                                                                                                 |
| What ought to be / are the ethical requirements to achieve scholarly recognition of our teaching efforts? |                                                                                                 |

**CSH: 6. What conditions of success ought to be/are not under the control of S?**
Systemic Practice and Action Research Phases Two and Three: Action Planning & Action Taking
Plan action based on literature to address the problem. Take action.

Sources of knowledge

CSH: 7. Who ought to be/is providing relevant knowledge and skills for S?
Who ought to be / are included in our personal development?
Who ought to / has experience in teaching prerequisite/follow-up modules in the degree programme?
How ought / can teaching and/or learning support provided by the institution be included?
How do we ought to / currently become aware of the latest trends in industry.
How ought / are the experts (be) included on the social experiences of students?
What sources of information ought to be / are considered to increase understanding of the context of our students?
What opportunities ought to / do exist to include students in decision making?
Which scholarly publications ought to be / is consulted regularly to ensure that our knowledge is recent?
How do we ought to / currently know that our own knowledge is sufficient to serve our commitment to expertise in content?

CSH: 8. What ought to be/is relevant new knowledge and skills for S?

Allocating time for self-development in terms of content knowledge enables the researcher to gain confidence from competence.
From our commitment to self-reflection and our understanding of the need for discourse, we have to ensure that we expand the decision-making group for a specific module.
Our commitment to our environment dictates that we might have to campaign for structural change inside the department to be more mission-oriented. The active involvement of industry in strategic planning should be encouraged.
Our commitment to our students should motivate us to provide opportunities for our students to report on their experiences during the action-taking phase. We should listen to their concerns and act with agility to improve problematic aspects of the instructional design.
We should be aware of the total context of our students in terms of residential context, as well as the context of other modules. This will enable us to guide the development of time management skills of our students. During the action-taking phase, there is an opportunity to develop the time management skills of students.
Being involved in academic organisations will enable us to form networks of scholars to guide our personal development. From our perspective this should include scholars from a variety of disciplines including, educations, action research and systemic sciences.
Action Research Phase One: Diagnosis

The aim of the diagnosis phase is to understand the problem based on initial understanding and from previous iterations of the AR cycle.

Which prescriptive educational theories ought to be / are available to apply to the development of each student into an autonomous, self-directed, lifelong learner, who takes ownership of their own success?
Do we ought to / currently understand the underlying assumptions made by our chosen methodologies?
What aspects of our own experience ought to / can be used to enhance the selected theories?
Ought / is the selected framework for understanding still (be) applicable?
Are there changes in the degree programme structure which we ought to / currently incorporate in our design?
What ought to be / are the latest trends in industry?
What process do we ought to / currently use to ensure that we are aware of new developments in the field of the specific professional practice education?
Which systems thinking literature ought to / are (be) used to improve our practice of systemic thinking?

In terms of our commitment to our own technical development, we are able to test life-long learning strategies on ourselves before including them in our teaching practice. In terms of our commitment to self-reflection and critical reflection, we are conscious of the fact that each related study has been performed in its own specific context. Before we apply a method found in literature, we need to reflect on the underlying conditions of success of that method. Non-critical application of methods and the following of trends are irresponsible in terms of the possible influence on all involved and affected. Agile response to changes in the environment requires deep knowledge of educational principles. We advocate good knowledge of foundational educational theory. Often degree programme structure is updated, influencing individual modules in terms of credits and, prerequisites and offering modes.

Our commitment to industry demands that we are aware of the latest trends in the industry and the theoretical knowledge required by students to be successful in an ever-changing professional industry.
Our commitment to the scholarly development of ourselves and others, inspires us to promote the explicit scholarly discourse within our department and other academic organisations.

As life-long learners who are ourselves involved in self-development of technical content knowledge, we are able to verify the success of candidate strategies on our own development. Since we are sensitive towards the underlying conditions of the success of chosen methods, we are hopeful that the success reported by developers of the methods will lead to success in our situations as well.

Our commitment to our individual students ensures that we make time to listen to the student without expecting rational argumentation. Our practice of CSH demands that we are able to transcend our own perspective and react to the experience of the students. We need to enter into discourse with the students and student assistants to uncover our own - and their - deceptions. Learning while doing is central to our methodology. In order to maximize the epistemological gain, we need to gather data as evidence in support of our learning trajectory.

Action Research Phases Four and Five: Evaluate & Specify Learning

Evaluate the success of the intervention and specify what learning took place in preparation for the next cycle, or in support of the completion of the project.

Revisit CSH 3: CSH: 3. What is the measure of improvement?
Action Research Phase One: Diagnosis
The aim of the diagnosis phase is to understand the problem based on initial understanding and from previous iterations of the AR cycle.

| How do we measure success after an iteration? |
| How is it possible to determine to what extent each student progressed into an autonomous, self-directed, lifelong learner, who takes ownership for their own success? |
| Which interventions proved to be successful? |
| Which interventions proved to be unsuccessful? |
| Are the measures of success true measures of the success of our intervention? |
| In which way do we supplement institutional measures with softer / less formal measures? |
| Did we, as educators, enjoy the module? |
| Did the students enjoy the module? |
| Did we achieve the personal development of our students? |
| How do we ought to / currently track the careers of our alumni and how do we attract their input towards improving our module? |
| Would our findings be beneficial to the larger scholarly community? |
| Should we reconsider our chosen framework for understanding and what we consider to be expert knowledge? |

We consider evaluation of success on two levels. Firstly, on an objective, measurable realist level: student performance is measured using summative assessment and throughput. University regulations typically require external moderation of assessment processes, which ensures that the grades of students reflect their mastering of the goals and/or objectives of the module. Secondly, we consider and promote subjective, informal measures of success. Student engagement, participation and joy are important factors to ascertain the success of our teaching. We can only be successful in the art of teaching professional practice if our students enjoy their development journey as practitioners. Our students won’t enjoy our modules when we do not enjoy performing our role as lecturer/ facilitator.

Most universities implement some form of module evaluation to be completed by students. It is important to critically evaluate the questions and the responses and to add questions on the enjoyment of students. Often the module under development is not a terminating module in a degree programme. Students first complete another semester/year of training before entering industry. There should be procedures to ensure continuous relations with alumni. Their perspective is valued in planning improvements to the instructional design of the module.

Learning from doing demands reflection and scholarly discourse. From the positivistic roots of our colleagues, we often experience resistance to our focus on enjoyment as measure of success. In specifying learning, we need to be critical of the applicability of our original selection of framework for understanding and the underpinnings thereof.

| Sources of legitimacy: |
| CSH: 10. Who ought to be/is representing the interests of those negatively affected by - but not involved - with S? |
| Who ought to be / are able to act as witnesses for the affected? |
| How ought / do we overcome our own resistance to critique. |
| How ought / do we involve future students in our system? |
| Who else is affected and not involved? |
| What publication opportunities do we have in order to widen our audience, in order to improve the experience of more students? |

Our commitment to reflection of the real objective of our teaching guides our attitude towards our students and especially their feedback.

Our commitment to self-reflection requires us to transcend our own perspective. Since we are aware that power relations in a lecturing environment discourage students to voice their concerns, we train our student assistants to listen to concerns of the students.

The role of future students and alumni should not be neglected as affected parties. The expectation of future students is an informal indication of the image of the degree programme in society. Alumni have had the benefit of time to consider the impact of our teaching strategies on their career. Their insights should inspire change and provide us with energy to continue successful practices.

In our experience, communicating the views of alumni to current students, improves their acceptance of teaching practices. Listening to the affected, we believe, is one of the most important contributions of the art of teaching professional practice and we should use every opportunity to communicate the benefits thereof to the scholarly community.
The scholarly contribution of our project (guided by our fourth commitment listed in Sect. 3) is to provide guidelines for the enhancement of an instructional design based on computational thinking.

**Action research cycle one**

We grouped the phases of the AR cycle, similar to Table 2, in three groups, starting with the diagnosis phase, followed by combining the action planning and taking phases and finishing with the combination of evaluation and specification of learning phases.

In terms of the scholarly contribution, we provided the background of the students as participants, in phase one. The literature used to guide the intervention is presented in the action planning phase, where initial guidelines for the enhancement of the instructional design is developed. Data collection is primarily done in the action-taking and evaluation phases. Data is collected from an interpretive research paradigm perspective (refer to Klein and Myers (1999)) and analysed using content analysis (coding as discussed by Zhang and Wildemuth (2009)). The initial guidelines from literature are refined in the specification of learning phase, before the second iteration commences. The study has received ethical clearance in the faculty and is conducted within the rules of the NWU.

The first iteration turned out to be a demonstration of the agility required in practicing the art of teaching a professional practice module since there was an unprecedented halt to cycle one during the action-taking phase. The original intention was to evaluate the success of the implementation of the action plan at the end of the semester (6 months). However, six
weeks into the semester, directly after the first large assessment, the students voiced intense dissatisfaction. After reflection, we accepted that we did not sufficiently consider students’ perspectives during the initial planning of AR cycle one. Substantial enhancements were made to the instructional design which constituted a second iteration involving the same group of students. The events of this first iteration provide us with a unique opportunity to critically reflect on our shortcomings and to improve the art of teaching a professional practice module methodology. The discussion here reflects on actual events and ideal events.

**Action research cycle one, phase one: Diagnosis**

In order to provide context, we briefly reflect on the environment of the system (module) in terms of CSH: 6. *What conditions of success ought to be/are not under the control of S?* The UIP2 module is one of five modules in the second year of the B.Sc. in Information Technology programme. The objective of the programme includes, amongst others, developing skills in all aspects of the software development lifecycle. The objectives of this module concern user interface design and implementation. It is presented at two different campuses of the NWU, situated in Potchefstroom and Vanderbijlpark which are about 120 km apart. UIP2 is a 16-credit module which translates into 160 h and has UIP1 as a prerequisite. The class size for the specific semester at the Vanderbijlpark campus - where we performed the study - was 118, of which 14 students were repeating the module. In terms of gender distribution, there are slightly more male than female students. The students are mostly between 19 and 20 years old. The alignment of all activities between campuses is expected by faculty management, but has never been achieved before, in this module. Our institution’s assessment policy defines certain rules and regulations to which each module should adhere to and necessitates individual assessments in order to confer the degree.

In terms of workload, the lecturer should only spend eight hours per week on all teaching activities pertaining to this module. In terms of resources of the system, *CSH: 5. What conditions of success ought to be/are under the control of S?*, the practical laboratories are used as lecture venues, where each student has a computer to work on during the face-to-face lecture. Discourse amongst students is encouraged in the classroom environment and on other communication platforms to solve problems collaboratively. Students are allowed to discuss the given programming problem and brainstorm problem solving ideas in a workshop setting. Discourse is encouraged during the completion of formative assessments as long as each individual student completes the task in their own way to showcase their progress in their learning. Discourse is not allowed during the completion of summative assessments as guided by the university’s policies and rules.

Third year students who successfully completed the module are used as assistants to facilitate the development of the problem-solving skills of the students. Since the module is presented on two campuses each, with a lecturer assigned to the module, the efforts can be combined to use resources efficiently. In terms of our commitment to our own technical competence, we are satisfied that we have the technical skills and foundational knowledge required to present the module.

At the beginning of the first iteration, we had never lectured this specific module in UIP at this institution and we relied on the study guides of both UIP2 and the prerequisite UIP1, as well as previous assessment instruments such as examination papers of both modules, to increase our understanding of the module and the prerequisite skills of the students. The
module had a negative reputation in the department, and we were expected by management to address the low throughput rate in order to address serious voiced concerns. We heard informally that past students told current students just to, “study old papers”, to be successful. Our actual diagnosis was lacking, since the aspects discussed here were rushing our decisions into solving problems, rather than teaching programming.

In hindsight we should have taken a step back and first reflected on the module and its position in the degree programme as suggested by CSH:1: *Who ought to be/is the intended beneficiary of the system (S)?* The students, industry and the faculty should benefit from our teaching of UIP. User interface programming has a unique ‘softer’ role in the B.Sc. in Information Technology programme. Its purpose (*CSH: 2. What ought to be/is the purpose of S?*) is to develop their skills in understanding user requirements in information systems and to practise skills in developing more user-centred interfaces, for mostly mobile applications. The development process of the applications should also mimic the industry processes used to develop software.

It became clear that we considered the study guides and past exam papers to be representative of reality, which had major shortcomings, as we later learnt that the former was barely used in the past. Students had an expectation of an easy module where they just had to study old papers. We underestimated the tremendous impact of deceptions of student perspectives. This module had never before achieved its intended role in the programme, and we did not take the messages in the hallways (polemical arguments) seriously enough. The students’ expectations on the measure of success [*CSH: 3. What ought to be/is the measure of improvement?*] turned out to be the root cause of their dissatisfaction.

We have always been sensitive to the position of control of the lecturer. However, reflecting on *CSH: 4. Who ought to be/is in control of conditions of success of S?* made us aware of the importance of communicating decisions to students. At the start of iteration, we were focused on balancing our position of power by relying on literature to support our decisions.

**Action research cycle one, phase two and three: Action planning & taking**

We began our action planning discussion with a reflection on *CSH: 7. Who ought to be/is providing relevant knowledge and skills for S?* In the current faculty structures, we work in the School for Computer Science and Information Systems. The management units are organised according to the different campuses (something we would prefer to change to module groupings to be mission-oriented). We found some support from the lecturer of the module at the Potchefstroom campus, but success at the Vanderbijlpark Campus is not a key performance indicator for the Potchefstroom lecturer. It should be noted that the socio-economic level of the Potchefstroom students is higher than that of the Vanderbijlpark students. The majority of Vanderbijlpark students study with government funding because of high poverty rates (Matukane and Bronkhorst 2017). As a result, many students do not own a computer. Government funding provides allowances for food and textbooks separately from tuition fees (NSFAS 2020). South Africa has a diverse culture and students at the Vanderbijlpark Campus represent various cultures (NWU 2020) which implies that students study in a language which is not their mother tongue.

In later iterations, we made several improvements after discourse with the lecturers of both UIP1 and UIP2 at the Potchefstroom campus. We achieved the anticipated full alignment of all activities during iteration four. The lecturer of UIP1 and UIP2 at the Vander-
bijlpark campus left the services of the university when we started the module. UIP1 was assigned to an inexperienced lecturer for one semester only, before we requested to lecture UIP1 also, as reported in iteration 3. In conclusion, although we were isolated during iteration one, we changed the communication structures and were able to form a cohesive intercampus team after iteration 4.

In terms of CSH: 8. What ought to be/are relevant new knowledge and skills for S? we conducted a literature study focused on the difficulties students face when learning to program and strategies to improve the programming skills in a problem-solving learning environment. From literature we developed initial guidelines to enhance instructional designs, in order to improve the programming skills of students.

Challenges that students face when learning to program include poor problem-solving skills (Govender et al. 2014; Havenga et al. 2013; Rahim et al. 2018; Saeli et al. 2011; Veerasamy et al. 2019); task complexity and cognitive load (Hazzan 2003; Qian and Lehman 2017; Sanders and Thomas 2007); natural language (Qian and Lehman 2017); poor abstraction ability (math ability, inadequate strategies and patterns) (Hazzan 2003; Lister 2011; Owolabi et al. 2018; Qian and Lehman 2017); poorly-constructed mental models (Ma et al. 2008:346; Qian and Lehman 2017; Rahim et al. 2018); environmental factors (Becker et al. 2016; Qian and Lehman 2017); and lecturers’ instruction and knowledge (Qian and Lehman 2017).

The chosen methodology for the improvement of students programming skills in terms of satisfaction and engagement is based on a computational thinking approach, which is referred to as a problem-solving learning environment (PSLE) (Lye and Koh 2014). The methodology focuses on enhancing computational thinking skills through the creation of a PSLE using Authentic problems (PSLE1 – Problems should be set within context with regard to the students); Information processing (PSLE2 – Computational concepts are acquired through information processing techniques that focus on mental model constructions; therefore, constructivism); Scaffolding (PSLE3 – Scaffolding the program construction into smaller more manageable tasks); and Reflection (PSLE4 – Students reflect on computational processes and their programming process, either by self-reflection or peer-reflection). Information processing (PSLE2) is vital within computational thinking. Constructivism deals with cognitive processes, and therefore the guidelines provided by Ben-Ari (2001) were used to ensure constructivist principles in the process of developing mental models. Ben-Ari (2001)’s constructivist principles for teaching computer science entails determining the desired cognitive change; confirming prior knowledge; developing abstraction abilities; facilitating the process of modifying a mental model; and incorporation individual reflection as well as social interaction.

In the action planning phase, an instructional design was researched and planned in detail according to the initial PSLE guidelines and enriched with constructivist guidelines. Relevant literature on specific interventions was used to determine whether it would be a suitable intervention or not, along with the lecturer’s intuition.

Our specific commitments, presented in Sect. 3.3 motivated our selection and application of computational thinking as the educational framework. Our main commitment is the development of each student into an autonomous, self-directed, lifelong learner, who takes ownership of their own success. We hope to empower the students with skills which will be to their advantage in other modules and in their careers. If we are able to enhance the
problem-solving skills of our students in this module, they should be able to apply the same skills in their other modules and in their future careers.

In terms of resources, the university provides certain student services, such as student assistants and supplemental instruction (SI). In order to optimise the use of available resources, we use the services of assistants and SI leaders as part of this course. Class assistants and SI leaders are older students who have already completed the course with distinction. Assistants are paid to assist during practical contact sessions, to provide more one-on-one help for struggling students. Student assistants also help to grade activities and provide feedback. SI is a service where the student-instructor presents sessions to students who have the need for additional explanation in the module. The lecturer nominates a student who they feel has the necessary skills to present these sessions, for extensive training. Studies have shown that peer-assisted learning and SI enhances students’ learning (Ning & Downing, 2010:921; Porter et al., 2013:34). Since the studies we used to develop our instructional design were conducted in comparable context, we used their results in terms of CSH: 9. What ought to be/ are regarded as assurances of successful implementation? We were very optimistic when we started the implementation of the first cycle.

During the action-taking phase, our commitment to listen to our students was accentuated. After six weeks of relatively good interaction, a group of students approached the student assistant and SI leader to voice a long list of grievances. We realised that the students were not ready for our way of teaching and decided to abort the specific implementation of our instructional design. Instead, we continued to the action research phase of evaluation to understand the position of the student.

**Action research cycle one, phase four and five: Evaluation and specifying learning**

During the evaluation phase of the AR project, we were especially sensitive towards understanding the position of the affected. We considered the final three CSH questions on the representation of the affected and the opportunities they have to voice their concerns. Our commitment to self-reflection made us continuously aware of our dual role as planner and as witness for the affected. We struggled as lecturers to provide the students with a fair opportunity to voice their concern. However, due to time constraints, it was not possible to involve external moderation before a total breakdown in relationships. We found the usage of the term ‘polemical argumentation’ by (Ulrich 1983) most helpful in enriching our own handling of the situation. He uses the term to promote representation of arguments by affected parties, with no need for sophistication or facts: voicing the concerns of the affected with the aim of bringing transparency of taken-for-granted assumptions of the planner (Ulrich 1983). The affected students’ polemical arguments should be interpreted, and underlying arguments should be brought into the open by the witness.

After the students completed their first evaluation, six weeks into the semester, a group of students talked to one of the student assistants and visited the academic administration office, with the intent of lodging a complaint against the lecturer. The students did not go through with the complaint at the academic administration office. The student assistant acted as an initial witness on behalf of the concerned and affected students. The lecturer acted as a witness for the affected students who visited her in her office and spoke to her after formal lectures. The complaints of the students as reported by the student assistant can be summarised as:
● The work pace is too fast.
● Work is too difficult.
● Lecturer does not explain enough.

From our focus on acting in different roles of power, we acknowledge that it is very hard to switch our roles. Awareness of the different roles is an important first step in the process of changing from the lecturer to the witness for the students. We have trained ourselves to expect polemical argumentation as opposed to rational facts when we make this switch. We have discovered that, as lecturers, we should make the switch to witness mode instead of taking offense at any moment when an emotional response is triggered. In this instance, the lecturer reflected on her own reaction to the message from the student assistant. When the message triggered an emotional response, she knew she had to change her role away from lecturer and planner, to that of witness representing the often polemical view of the affected.

After becoming aware of the students’ views, we tried to use all opportunities to improve our understanding of the problems experienced by the students. We needed to ascertain if the problem was with our theoretical framework of creating a PSLE, or with the implementation thereof. One such opportunity arose when two students visited the lecturer’s office because of a low mark received for an assignment. The conditioned realities for students A and B are presented in terms of the following concerns:

● Student A was not satisfied with the way that the lecturer awarded marks for her assignment;
● Students A and B prefer coding together on assignments and were upset for receiving zero for copying; and.
● Students A and B could not mention any factors that made learning to program hard for them.

As witness for these two students, the lecturer represented the students’ case in terms of the following items:

● Student A’s assignment mark was not satisfactory, and she was concerned about her performance, not knowing where she went wrong, or whether she might need a re-mark.
● Students A and B did not yet have the confidence to attempt assignments on their own and preferred to work together for moral support.
● Students A and B could not pinpoint exactly what made learning to program hard for them: they just knew that it was.

We found that in order to make it possible to represent the position of the students fairly we needed to explicitly articulate our own conditioned response as lecturers:

● Student A did not work according to the criteria of the assignment; if she did, she would have scored a higher mark for her assignment.
● It seems like student A did not work through the suggested solution after receiving her marks, which was available before visiting the lecturer, because she would have then seen that the marking of the assignment was fair.
Students A and B did not grasp the goal of the assessment which is to showcase their own learning progress and that collaboration is allowed as long as they apply their knowledge and skills in their own attempt: for example, applying computational thinking skills such as problem-solving, decomposition, abstraction, algorithms, debugging and iteration; and.

Students A and B might not have felt comfortable being honest about factors influencing them learning to program, or maybe they could not list specifics.

We can, however, only improve the situation if we step back and consider all conditioned realities carefully, with the aim of making constructive changes to the instructional design. After more conditioned realities were considered (not all presented here), a list was compiled of students’ perspectives about learning to program within this context, which included:

- Students experience time constraints because of a heavy load in their second year and sometimes in their third year, when repeating the current second-year course.
- Adequate prior learning (preceding course) is not in place.
- Inadequate problem-solving skills.
- Prefer working with other students.
- Poor mental models from preceding course.
- Difficulty adapting from a non-challenging environment to an environment where problem-solving was a main component.
- Comfortable to approach lecturer when in need of assistance.
- It became clear that there is a special need for a PSLE based on computational thinking, but that we needed to change the implementation thereof. We are indeed concerned that we do not succeed in transferring ownership for learning towards the students.
- A systemic problem came under our attention as a possible root of the unhappiness and the breach of trust. We view assessment as a formative activity used to shape the knowledge of the students. We should have better understood the attitude towards assessment as testing demonstrated by the students. We neglected to promote the relational aspect of assessment (Gergen and Gill 2020). According to Gergen and Gill (2020) assessment becomes a partnership between different stakeholders. Our students did not consider themselves as part of a partnership. Historically they were never part of any partnership, so although our attitude towards assessment was one of shaping knowledge the attitude of our students was vastly different. We had to win over their trust in this regard and create a new conceptual framework towards testing to achieve our goals.

In the specifying learning AR phase, we were able to reflect on the abbreviated first iteration. It is evident that the lecturer had ‘taken for granted’ normative claims, such as expecting prior learning to be in place, which influenced the success of this cycle’s intervention. In order to move closer towards the totality of conditions, the lecturer had to act as witness for the affected, and reflect as a lecturer, with consideration for student performance and participation in the problematic situation. If we had not honoured our commitment to consider the voice of the affected and considered the complete experience of our students, the researcher/lecturer would probably have just continued to complete the semester before any evaluation took place. Based on the evidence presented here, a pragmatic decision was made to intervene again. The voices of the affected students cannot be ignored and therefore this cycle...
ended within the first six weeks. A major misconception in terms of the role of assignments was identified: Students viewed the assessments as tests, while the aim of the lecturer is that of self-evaluation. The students are conditioned to score marks and not to focus on understanding. The class work focuses on collaborative learning and peer support to enable the students to develop the skills required. The aim of the specific individual assignment which lead to the negative response of the students, was to enable self-reflection on individual development. However, we realised that we underestimated the negative consequences of over-testing (see Gergen and Gill (2020)) and should have better explained our strategy to the students prior to the submission date.

After discourse with colleagues and reflection in AR cycle one, we decided that students need a certain level of readiness in order to ease into the instructional changes made, and therefore decided that we needed to focus on UIP 1 in AR cycle three, to create a level of readiness for the instructional approach followed in UIP 2. The learning during this cycle became the diagnosis for cycle two. The actual interventions based on the selection of theoretical framework used, could not, as originally intended be evaluated yet via formal interviews. It was clear during the first cycle that trust and relationship-building with students as well as communication regarding the justification of selected strategies, were crucial to the success of the planned interventions.

A new list of difficulties that students face when learning to program, was compiled, taking the polemical arguments which represent the affected students into consideration, as well as the rational arguments from the lecturer. This approach ensured that different perspectives were included in the diagnosis of the next AR cycle.

**Action research cycle two**

The second AR cycle commenced six weeks into the semester, after the evaluation that caused the dissatisfaction. They were thus the same students as in cycle one, in their sixth week of a twelve-week semester. As describe earlier, this intervention was a result of an agile response to concerns voiced by students.

**Action research cycle two, phase one: Diagnosis**

The *diagnosis* phase started with a list of guidelines to improve the programming skills of students, which was based on difficulties experienced when learning to program, as identified in AR cycle one. We were reminded in the first iteration to pay more attention to the range of possible reactions (intended and unintended) of the students. When listening to the students we are always confronted with conflict in terms of the sources of control in a specific module. Students find learning to program difficult and not all students will be successful in their attempt to succeed. This does not mean that we should lower our required standard nor neglect the development of the self-directed learning of the students. Agreeing to provide an ever-increasing amount of guidance is not to the long-term benefit or our students. As a result of our commitment to past and future students, we have to maintain the standard of skills required in this module, even when it leads to complaints, unhappiness and students failing the module. Our commitment to the individual student motivates us to increase communication to at least attempt to convince the students that the challenges they experience are a crucial part of their preparation for their careers in industry. Our commit-
ment to our students is ultimately to develop them as self-directed, autonomous, life-long learners.

Our commitment to industry reminds us of the danger of coaching our students to success without them developing the required problem-solving skills. Keeping our commitment to industry in mind, we plan interventions for this iteration based on the lecturer’s and students’ perspectives (4.1.3), for example creating even more opportunities in class for collaboration in problem solving through peer worksheets; completing a project in groups of two as part of a larger assessment; hosting additional workshops in smaller groups to allow more time to internalise concepts; reiterating an open-door policy to students; and allowing enough time to complete practical work in class when the lecturer and assistants are available. Not all people who aspire to it, can be successful programmers. Computer programming requires a specific skill set which includes a high amount of self-directed learning and problem investigation. Computer programmers are used to struggling with the same problem for days on end before finding a solution from an unexpected source, after an enormous effort.

In every cycle we reconsider all aspects of the first diagnosis. This time we discovered that the contact time allocated to UIP 2 on the Vanderbijlpark campus was less than on the Potchefstroom campus. This situation was rectified within the constraints of available laboratory time. The diagnosis phase concluded with an improved understanding of the specific barriers of our students. There was no evidence to suggest that our theoretical framework of computational thinking was inappropriate. Our renewed awareness of the importance of skills development, rather than coaching, renewed our commitment to computational thinking as a guiding framework.

**Action research cycle two, phases two and three: Action planning and taking**

During cycle one, we developed guidelines from literature to enhance the instructional design of teaching programming. Although we could not evaluate the success of each guideline in cycle one, we decided, based on what we learnt during cycle one, to enhance the guidelines with intervention requirements in order to make them more practical. An example of enhancing each guideline with an intervention requirement is shown in Table 3.

| Cycle one Guideline one | Intervention requirements |
|------------------------|--------------------------|
| Prior learning must be in place: more specifically, existing viable mental models that can influence a student’s lack of engagement and apparent lack of responsibility. | Revisit concepts needed to complete current course, even if it includes concepts from previous courses. |

| Table 3 Example guideline and intervention requirement |
|-------------------------------------------------------|

Based on our commitment to our individual student (past, future and present student), communication with students about the purpose of our actions was important. One of the interventions planned included an intervention talk, which had a dual purpose.

Firstly, the lecturer aimed to explain the importance of attaining the module objectives, and of the need for a deep understanding of programming in order to become good programmers in society, instead of the lecturer lowering the standards in order to achieve a higher pass rate. The aim of evaluations as opportunities for self-reflection was highlighted to students. The weighting factors of the formative evaluations were reduced in order to demon-
strate their purpose to students. Students were encouraged to use the assignments as they are intended, as opportunities to measure their improvement and not as events to create a pass mark for the module. We had to change the attitude of the students towards our evaluations. The interaction of repeating students was used in this motivational talk. During office visits, two repeating students mentioned the importance of the current approach in preparation for their final year, since they were already busy with some of the final year modules.

Secondly, the interventions that were planned, were conveyed. Specific aspects of this intervention talk included:

- Our commitment to the development of each student into an autonomous, self-directed, lifelong learner, who takes ownership of their own success and how that requires that the students be aware of their responsibility for their own development. Collaborative problem-solving opportunities forms part of the module and are encouraged in the forms of interactive classes, peer worksheets and a project in groups of two, but the importance of being able to demonstrate individual progress as well is part of the university environment and industry expectation. Assessments allow students a platform to showcase and measure their own progress.
- Providing the students with a relevant IT industry position vacancy advertisement and asking the students to reflect on - and assess - their own abilities, to determine whether they would qualify for the entry-level position, since this is technically the last core programming course in their curriculum.
- Discuss the importance and relevance of the course in terms of the overall degree objective and their development as well-rounded graduates.
- Explain that no programmer knows all the answers but will need to investigate and construct viable mental models, and that problem-solving forms a major part of this process.
- Explain to students that the lecturer does care, and direct communication is key to a successful relationship.
- Explain that an attitude change is necessary to improve performance in the course.
- Discuss additional opportunities that will be provided and that it was not too late to still achieve the objectives of the module (SI, additional class, assignments etc.).

Based on the involved lecturer and affected students’ conditioned realities about whether interventions were successful or not (outside the scope of this paper), new interventions were considered (action planning) based on possible interventions, which were identified in the literature study. An updated instructional design (plan) was formulated, and action was taken. The evaluation took place after the semester had been completed.

**Action research cycle two, phases four and five: Evaluation and specify learning**

Each student brings his/her own conditioned view to the classroom. Our methodology commits to having passion and consideration for individual students. The totality of conditioned realities is an ideal, but understanding more conditioned views enhances the understanding of the problematical situation (Ulrich 1983). The conditioned views are presented in the sections that follow, where data is collected, analysed, and presented in terms of findings portraying the polemical views of students.
The polemical views of the affected students in the form of formal interviews were presented, and analysed using Zhang and Wildemuth (2009)’s analysis guidelines - and findings were specified. During interviews, the researcher engaged in conversation with the participant and was able to elaborate or rephrase questions if required. Many questions are open-ended, which allowed the researcher to request elaborations when necessary, as suggested by Kaplan and Maxwell (2005). The questions were either linked to the actual interventions used, and/or the PSLE aspect addressed. Some questions were open-ended in an effort to learn as much about the students’ perceptions of the instructional approach followed and their experience of the interventions used, as possible. The interviews took place face-to-face and were recorded in order to transcribe in Atlas.ti. They were then coded and analysed. From a critical systems perspective, the aim of the data collection is to understand, listen to the affected, and to ‘sweep in” (Ulrich) any relevant information.

An example of an evaluation is provided in Table 4. Codes were grouped according to each intervention used (Intervention code: Actual intervention (AI) and a number) in terms of a positive or negative response from students during interviews. If there were predominantly positive codes, an intervention was perceived as positive from the students’ perspective. If most responses were negative, an intervention was seen as negative. Equal responses were seen as unsure. If an intervention was positive, even the negative codes were considered where learning was specified, since it represented another conditioned reality and vice versa.

The codes were also mapped according to the PSLE. The overall perception of participants supported the PSLE instructional approach that deals with concepts in-depth with a hands-on approach. No changes were suggested, except that cheat-sheets should not be used. In particular, students felt positive about the lecturing style which included the intervention strategies for AR cycle two (Table 5). The university also allows for anonymous feedback on every module taught. The above is confirmed with the anonymous evaluation completed by students as shown in Table 6. This demonstrates that the students were satisfied in terms of the instructional approach and lecturer engagement.

Table 4  Students’ perceptions of success of actual interventions used for AR cycle two

| Actual intervention | Codes + | Codes - | Success |
|---------------------|---------|---------|---------|
| AI1: Read a chapter before each study unit | 85       | 86, 87, 88, 90 | No |
| AI2: Watch tutorial videos | 94, 96   | 93, 95   | Unsure |
| Code: 85: Textbook: prepared before class occasionally |          |         |        |
| Code 86: Textbook: irrelevant textbook |        |         |        |
| Code 87: Textbook: never prepared before class |        |         |        |
| Code 88: Textbook: only used it in class |        |         |        |
| Code 90: Textbook: preferred the lecturer as source |        |         |        |
| Code 93: Videos: did not watch all because of external workload |        |         |        |
| Code 94: Videos: were relevant |        |         |        |
| Code 95: Videos: watched some |        |         |        |
| Code 96: Videos: watched videos when content was difficult |        |         |        |

- Representation and analysis: Polemical views of the affected students during formal interviews

- Representation, analysis and findings: Lecturer’s rational perspective
The lecturer’s perspective was also taken into consideration. The lecturer’s perspective is based on performance as well as their intuitive perception. An example of how the final success of interventions that were used, were determined, are listed in Table 7. The student and lecturer’s views were considered (as another conditioned reality) and discussed, in order to determine the final success of interventions used. An intervention’s overall success was determined as follows: Yes and Yes = Yes; Yes and No = Unsure; No and No = No; Unsure and No = No; and Unsure and Yes = Unsure.

- **Specify learning**

In order to update the guidelines and instructional design, students’ views as well as the lecturer’s views were combined to form categories in terms of the instructional design (Table 8).
After this evaluation, learning was specified in terms of updated guidelines, taking the success of specific interventions as well as various perspectives, into consideration. The updated guidelines considered negative and positive evaluation results, since all results represented conditioned realities. A total number of 11 guidelines were compiled at the end of cycle two, based on specific interventions. Improvement was measured in terms of satisfaction and engagement and it was clear that students were satisfied. One of the guidelines that was added in cycle two is that the lecturer engagement with students is very important. Students long to connect with the lecturer and have a good relationship with the lecturer. This was based on students’ and the lecturer’s perception that more engagement with students, did change student’s attitudes towards learning.

### Action research cycles four and five

The updated guidelines and instructional design developed here, formed the basis for the diagnosis of the next AR cycle. The understanding of difficulties that students face when learning to program were enriched after each AR cycle. Reflection on the tremendous change in student attitude from the beginning of the first cycle until the end of the second cycle, inspired us to request permission to lecture UIP1, the prerequisite module of UIP2. Discussion of the cycle three (teaching UIP1) is outside the scope of the paper since it is very similar to the discussions above. We focused on the communication of objectives and the importance of specific aspects of the module for industry success. We continuously communicated with the students to manage their expectations of the type of guidance we are prepared to provide them. We were able to show them that problem-solving is enjoyable and that the challenge to solve the unknown problem successfully is the reward for the programmer. Our focus on the students’ awareness of our personal care once again turned out to be crucial to our success. In cycle four, when the same group of students did UIP2, we had a very good experience, since the students had a realistic expectation of the instructional design and the demands of the module.
In terms of scholarly contribution, we refined the eleven guidelines for enhancing an instructional design for teaching programming, according to the principles of computational thinking. Since the focus of this paper is on critical systems thinking, a lengthy discussion of computational thinking and the resulting guidelines is outside the scope of the paper.

**Conclusion**

Having lectured a professional practice module for a long time, we realised that we do not have the answers for many of the problems and that understanding the problem was part of the solution. We used Ulrich (1983)’s work to increase our understanding of the problem in terms of boundaries such as resources and environment and also the involved and affected. Aspects we initially considered part of the environment and problematic became part of the resources and the success of the intervention. We were reminded that while using the resources under our control, we had to consider our own position of power, and the vulnerability of the affected students.

The art of teaching a professional practice module employs Ulrich (1983)’s work on critical systems heuristics to articulate five commitments that guide all interventions in the problem environment. The first - and perhaps most important – commitment, is that of self-reflection. Every action should be reflected upon in terms of the underlying assumptions thereof and the consequences possible. Empathy with the students, was crucial to our understanding the situation. Ulrich provides guidance for the ‘planner’ and we neglected our ‘planning’ activity in the first iteration by focusing too much on the ‘ought to’ mode of our planning and not enough on the ‘is’ mode. The ‘is’ mode guides diagnosis of the problem which should ideally be completed before any concrete changes are implemented in the problem situation.

There are many aspects we cannot control in our problem situation and our second commitment to understanding our environment, proved even more useful when we repeatedly analysed - and were willing to change - what we consider to be outside the boundary of our system. One such item was the traditional attitude towards assessment of our students which was different from our own attitude. We support the idea of forming relationships and including the students as stakeholders. We underestimated the different conceptual views of our students who view assessment as tests to be passed with the highest marks possible. We had to work very hard on our relationship with our students to show them that assessment is an integral part of forming their knowledge and not only an summative action.

Our third commitment to our individual student opened our minds to what Ulrich calls polemical reasoning, in order to provide the student as affected party, with a voice. An important lesson (and guideline) that arose because of this, was the importance, to the students, of lecturer engagement, which was increased substantially during the subsequent cycles, and contributed towards the success of those cycles. In support of this, it was noticeable that the relationship between the students and the lecturer improved because students approached student assistants during cycle one, but had the confidence during cycle two to contact the lecturer directly. Relationships between students and the lecturer is critical. This aspect was neglected at the start of the semester but proved vital in the success of the intervention.
Our fourth commitment to the wider situation of our current, past and future students, as well as their future in industry, at the core is problem solving: something we cannot coach our students to be successful in. We can, however, guide them with problem-solving strategies, and we can develop their love of the challenge and the reward of success.

Our final commitment towards scholarly contribution guided us to reflect on the suitability of CSH in this problem domain. Our multiple roles as expert, planner, and also witness for the affected, continues to be a major challenge. It was challenging to provide a fair platform for the students to voice their often polemical arguments, without a response from the lecturer’s perspective. It could be useful to include a third party, but we did not have time for such a process during the conflict situation in cycle one. We had to determine when to act as witness and when to act as the expert. We decided to step back as lecturers, and assume the role of witness the moment when an emotional response was triggered by a problematical situation, even if the lecturer in us disagreed with the argument. We did reflect on our own response as lecturers and presented it as the lecturer’s perspective.

The action research process in this study deepened the research and broadened the action just as Flood (2010) suggests. It enabled us to plan, execute and evaluate emancipatory actions recursively. The professional practice skills of students improved in terms of performance, satisfaction and engagement. More importantly, in terms of this paper, the students’ experience changed from an initially negative experience to a predominantly positive experience, because of an improved relationship between the students and lecturer as a result of listening to the affected students. This research not only benefited the students involved but also future students. The guidelines developed will enable another lecturer to plan their strategy, sensitive to the experience of this study.

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**Declarations**

**Conflict of interest** The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Authors and Affiliations

Suné van der Linde¹ · Roelien Goede¹

Suné van der Linde
sunevdlinde@gmail.com
Roelien Goede
roelien.goede@nwu.ac.za

¹ Computer Science & Information Systems, North-West University, Potchefstroom, South Africa