

Life Sciences Case Study 2 – Level 6	
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Setting	Third year dissertation module (Level 6) in a Life Sciences Department (module title: 'Individual Study'). The module requires students to carry out an individual research project for which they develop a proposal, carry out a risk assessment, design and carrying out experiments and/or fieldwork and analyse the data obtained for an oral presentation and a written thesis.
Cohort Size	50 students
Rationale for using the Toolkit	The dissertation module at the end of a three year undergraduate programme is typically one of the most challenging learning experiences for students. In the life sciences, students typically have to conduct an independent research project under supervision of an academic tutor, working to their own schedule and at their own initiative. At Canterbury Christ Church University, students have the additional freedom (and challenge) of choosing and designing their research project – they are not required to carry out a pre-designed and planned experiment. This often causes considerable anxiety for students as it requires application of a number of high-level skills that they may not have used frequently before, such as how to design an experiment, choosing a suitable measurement device and planning a project with a statistical analysis method in mind. An additional challenge presented itself for the cohort involved in this case study because the University transitioned to a semesterized academic timetable. This meant that students only had ten calendar weeks to carry out all of the necessary research and practical work for their project. This meant that project preparation had to occur much earlier than with previous cohorts, before they had completed their second year of study. The Traffic Lights Toolkit was used to support students in their preparation of their projects and at key points in time during the project execution and thesis preparation phase.
Learning activity	Students were first briefed about the dissertation project module in February of 2017, half a year before the official start date of the next academic year when they would have to complete it. To encourage early completion of all necessary preparation, they were set a deadline for a completed project proposal in mid-May 2017. They then had ten calendar weeks during Semester 1 of the following academic year to complete their research. A part of the cohort was to complete their project in Semester 2, they are not included in this case study, though data collection is still ongoing for this group. At the end of the semester, students were summatively assessed in an oral presentation and via a written thesis that included a record of their practical work in the form of an online log book (delivered via PebblePad) and a thesis in the form of a manuscript written to the author guidelines of a peer-reviewed journal.
Traffic Lights Toolkit elements used	Perception of Challenge Tool, Quadrant Tool
Mode of delivery	Paper (first sheet) and digital (subsequent two sheets; Excel spreadsheet). The Traffic Lights Toolkit (Perception of Challenge Tool;

	POC and Rating Scale Tool; RT) was delivered as part of the summative assessment for this learning experience by being integrated into the online log book students had to complete.
Number of engagements with the Toolkit	3
Aims	Integral to a dissertation module like the 'Individual Study' module is that student collaborate and work with an academic supervisor. Regular meetings with the supervisor are part of the summative assessment of the module (10% of the module mark are based on a supervisor's assessment of the student's engagement). The POC therefore included statements relating to the skills students were to develop and that were being assessed as part of the module and students were encouraged to discuss the tool with their academic supervisor at key points during the preparation and execution of their research project. Reflection is an integral process in designing experiments and optimizing experimental design as well as in the process of carrying out research and analysing and interpreting experimental results. Asking students to engage with the Toolkit was intended to signpost the required skills for students, allow them to identify areas of existing confidence but also highlight areas of concern that they should prioritize in conversations with their academic supervisors. The PoC tool was therefore included to facilitate this process. The Quadrant Tool was included to help students identify where they needed additional direction (i.e. for self-motivated work which is a fundamental element of a dissertation project) and support (i.e. where they needed to interact with an academic supervisor or technician to develop a skill).
Methods	First use of the Toolkit: Students were briefed on the 'Individual Study' module and the timeline for preparation and completion of their project in the second term of their second year (February). As part of this briefing, they were introduced to the POC and RS Tools and the aim of including them as part of the module and the summative assessment. Students were told that they would be assessed on their engagement with the Tools as part of their log book mark, but not on the content of the Tools they completed. The POC Tool had twelve statements, grouped by the themes 'Project preparation', 'Project execution' and 'Project presentation' (Table 1). For each statement, the POC Tool included a space to indicate the traffic light colour, a space for adding a numerical confidence rating (1-10) and a space for notes, thoughts and comments.

Table 1: List of skills statements included in the Perception of Challenge Tool. Statement 10 (marked with an asterisk) was included only in sheets number 2 and 3 to allow students to self-assess progress on their project as a whole.

Project Preparation	1. I can turn a research question into a specific, testable hypothesis.
	2. I can design an experiment or project to test the hypotheses I have generated.
	3. I know how to design my project so I can use simple and effective analysis on my results (e.g. statistical).
	4. I can search and read the scientific literature to find papers and methodology relevant to my project.
	5. I can effectively and confidently communicate and work with technicians, my supervisor and any external partners.
Project Execution	6. I know how to use the laboratory equipment, reagents, software etc. needed to complete my project.
	7. I understand the procedures around risk assessment and chemical safety relating to my project.
	8. I can manage my time effectively to carry out my work in good time.
	9. I know what to do when I an experiment or piece of equipment is difficult or not working as expected.
	10. I feel like I am making good progress on my project and that I will be able to complete it in the time available.
Project Presentation	11. I can carry out the statistical or other analysis suitable to the data I have generated.
	12. I know how to structure and write a thesis according to the author guidelines of a scientific journal.
	13. I know how to effectively present my work and results to an audience of my peers.

The first Toolkit sheet was delivered on paper in the briefing session. Students were given a double-sided printed copy, with the POC Tool on the front and the Quadrant Tool on the back. They were encouraged to reflect on their confidence levels at the time and were encouraged to add any notes, thoughts and comments in the provided spaces so they could articulate for themselves and for their academic supervisor why they felt a certain way. Students were given small coloured stickers that they could use to record the colours indicating their confidence in the appropriate column. They were also encouraged to discuss amongst each other their responses to statements and feelings about them to encourage reflection and a shared experience. They had approximately

	<p>half an hour for this activity. At the end of the briefing, students retained their sheets and were instructed to discuss them with their academic supervisor as they met with them to develop their proposal, specifically to identify areas of concern and arrange for direction and support in those areas. Students were also instructed to submit a scanned digital copy of the sheet with their project proposal via Turnitin, including a signature from their supervisor on the sheet to indicate that they had been discussed. Academic supervisors were briefed to expect students to discuss the Toolkit sheet with them, though the main responsibility for doing so remained with the student as a sign of their engagement.</p> <p>Subsequent uses of the Toolkit: Each student was given access to an online log book from the beginning of their practical project work to record their work. Students had to complete ten weekly log book entries. At two further points during the project, students were prompted by a special 'Traffic Lights Toolkit' page in the online log book to complete a digital Toolkit sheet with the POC and Quadrant Tools, though these were in a digital format. The page included instructions for completing the digital version of the sheet and a link to download a template as well as upload the completed file. Each of these instances coincided with a critical time point in the project -- the halfway point and the last week of practical work, as students began preparing for the assessments. Students were reminded to complete these sheets and attend meetings to discuss them with their academic supervisors in the week prior to them becoming available, both via timetabled briefing sessions and via eMails and announcements posted to the VLE .</p>
Sharing and evaluating outcomes	<p>Students had access to their own sheets at all times during the project, so were able to assess their progress and growth in confidence by comparing newly completed sheets to those completed previously. Due to the individualized supervision students received and the lack of any group sessions at the end of the module, the collated data from the submitted POC/Quadrant spreadsheets were not shared with the students as a whole. However, they will be shared with students in the following cohort(s) on this module to illustrate the utility of the tool and the learning journey taken by students before them, as well as to emphasize the importance of reflection and autonomy in learning. At the beginning of the oral presentation sessions at the end of Semester 1, students in attendance were asked to complete a questionnaire on their experience with the Toolkit.</p>
Outcomes	<p>Engagement with the Toolkit was mixed: though 86% of the 50 students who completed their dissertation in Semester 1 completed and submitted at least one of the three Traffic Lights Sheets, less than half (38%) completed all three. However, considering the significant gap in time between some of these engagements with the tool (e.g. up to 8 months between February 2017 for sheet 1 and October 2017 for sheet 2), this was considered a positive result and the integration of the</p>

Toolkit into the assessed online log book was probably helpful in re-engaging students with the tool.

In general, all students reported an increase in confidence for most or all of the skills statements included in the Perception of Challenge Tool. This is illustrated by the 'confidence map' that compiles green, amber and red colour indicators provided for each statement by students (Fig 1). However, not all statements had become 'green' or even 'amber' for all students. Particularly the final statement 12 (13 on second and third sheets), which related to presentation skills, was a source of concern throughout the project and remained amber or red for students throughout. In response to this, a presentations skills briefing was run in advance of the presentation assessment to prepare students for the presentations and reduce anxiety.

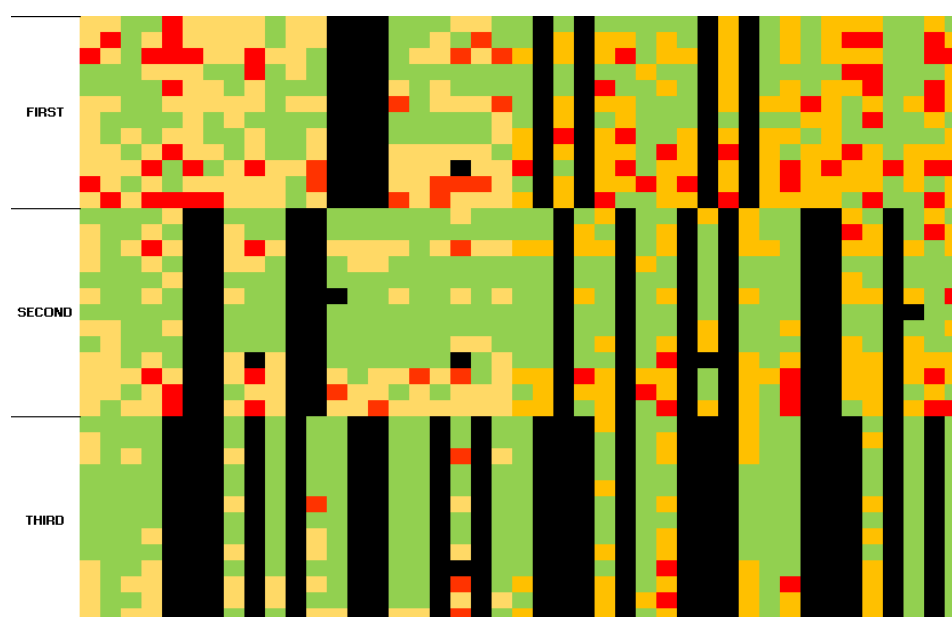


Fig 1: Colour map indicating self-reported confidence levels of students in relation to twelve (first and second sheet) or thirteen (third sheet) skill statements across three separate engagements with the Perception of Challenge Tool. Green = Confidence, Amber = Challenge, Red = Stress/Anxiety. Each column represents one student, each row one statement. The responses to the four Toolkit sheets are separated by bold horizontal lines. Black squares indicate missing data. N = 43 students.

The way students placed each of the twelve statements from the Perception of Challenge Tool in the two-dimensional space of the Quadrant Tool to indicate their need for Direction (x-axis) and Support (y-axis) revealed that while the need for direction and support differed between statements at the outset of their project planning, students also felt they required direction and support in approximately equal measure for each of the statements. The mean position of statements along the Direction and Support axes was similar for each statement (Fig 2). Moreover, over the course of their project, there was a highly significant relationship between reduction in need for support and in

reduction of need for direction (Linear Regression; Coef. = 0.646, $F_{1,23} = 19.57$, $P < 0.001$; Fig 3). This means students who became less dependent on direction also became less dependent on support.

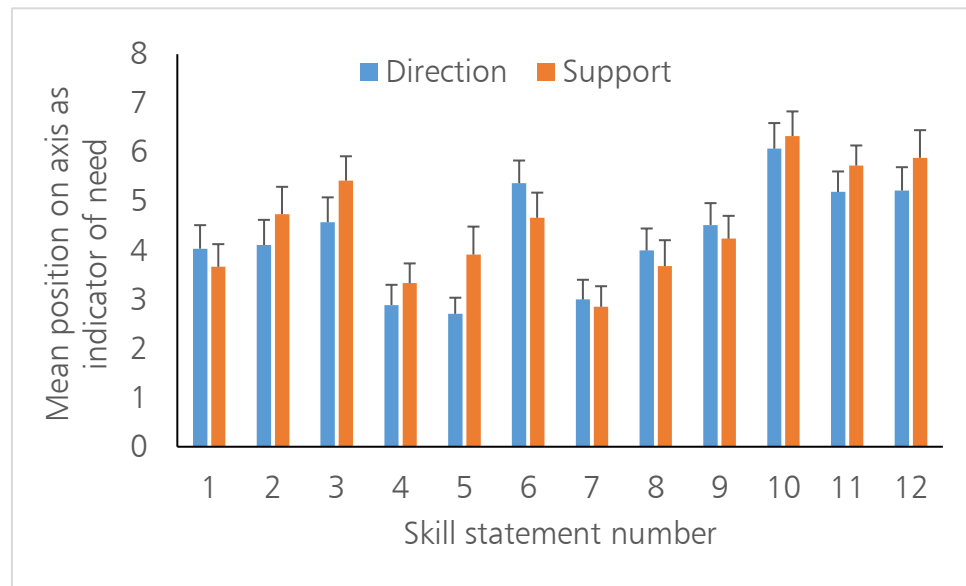


Fig 2: Mean position of skill statements on each of the two axes (direction and support) in the Quadrant Tool.

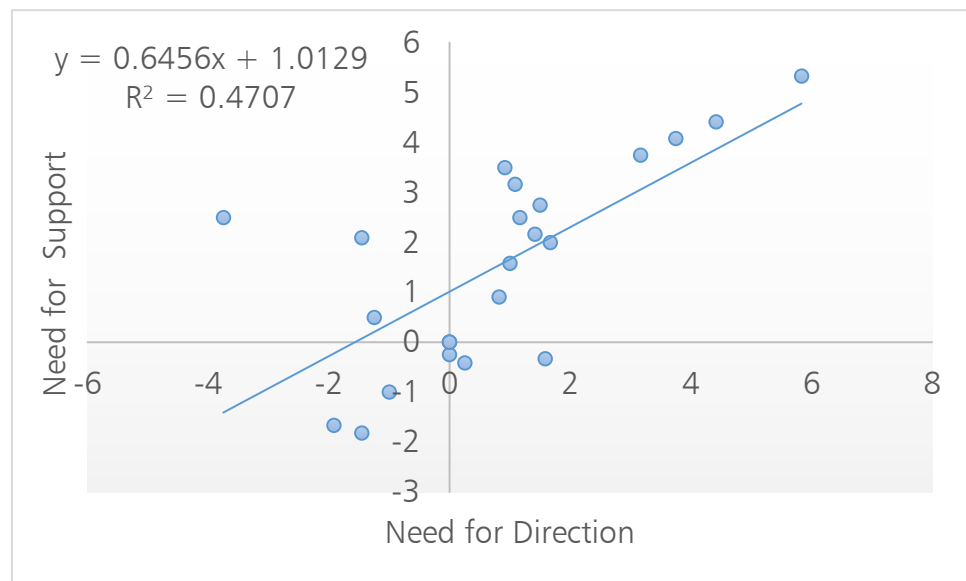


Fig 3: Relationship between the change in need for direction and the change in need for support from the first to last Traffic Lights Toolkit sheet completed by students (N=24).

Interestingly, however, the reduction in the need of support was greater than reduction in need for direction when comparing the first and last sheet completed (Fig 4). This could indicate that as students progress through their studies and their project and reflect on their changing needs, they are reporting increasing levels of autonomy where they

require more direction towards resources for independent study, but not as much direct support and interaction with a tutor to learn. The Toolkit captured this growth in autonomy and may also have contributed to it.

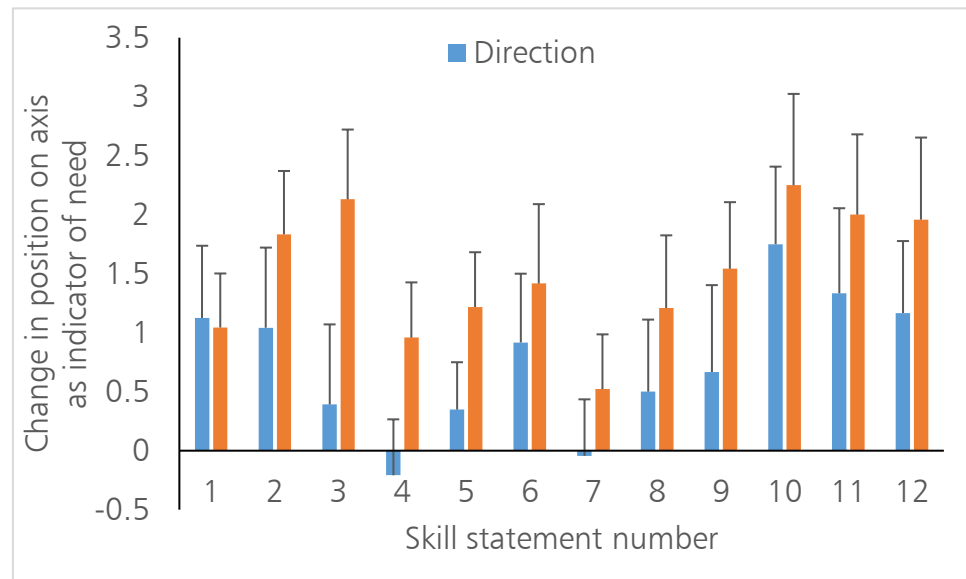


Fig 4: Mean change in position of skill statements on each of the two axes (direction and support) in the Quadrant Tool from first to last Traffic Lights Toolkit sheet. The higher the number, the greater the reduction in need (statement moved toward the origin of the coordinate system).

There was no significant relationship between confidence levels of students at the initial briefing stage of the project (February 2017) and their achievement in the assessments almost one year later (Spearman's $Rho = 0.136$, $P = 0.445$; $N = 34$; Fig 5). Likewise, there was no significant relationship between gain in confidence level from the first to the last sheet and attainment in the assessment (Spearman's $Rho = -0.156$, $P = 0.523$; $N = 19$; Fig 6). There was some evidence to suggest that greater engagement with the Toolkit was linked to higher achievement on the module assessment, however. When marks were grouped by the number of Toolkit sheets a student had completed (1, 2 or 3), students who completed all three of the sheets achieved significantly higher marks than those who only completed one of the three (One-way ANOVA with Tukey's test, $P < 0.05$; Fig 7).

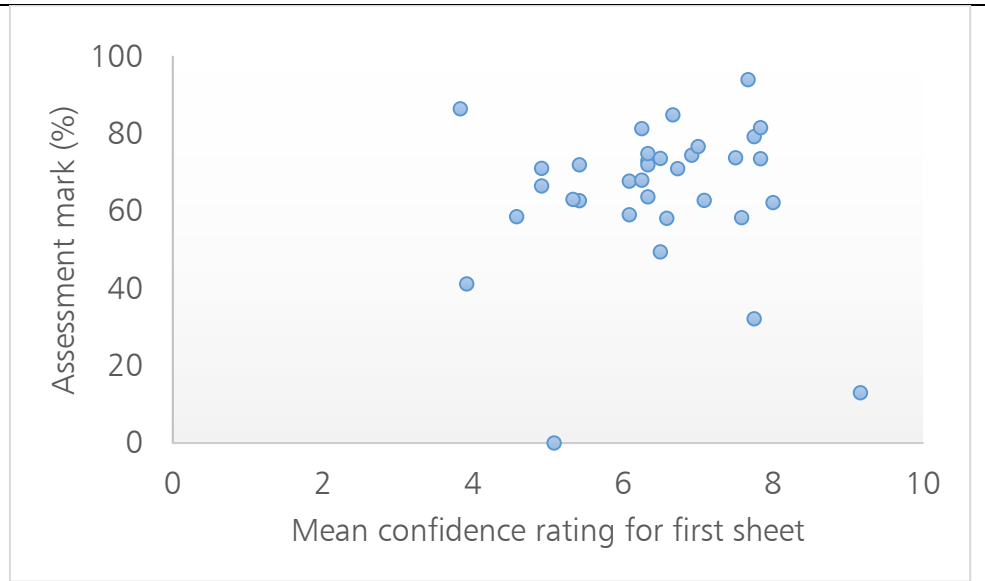


Fig 5: Correlation of mean confidence rating per student (mean of responses to all statements on first sheet) with assessment mark.

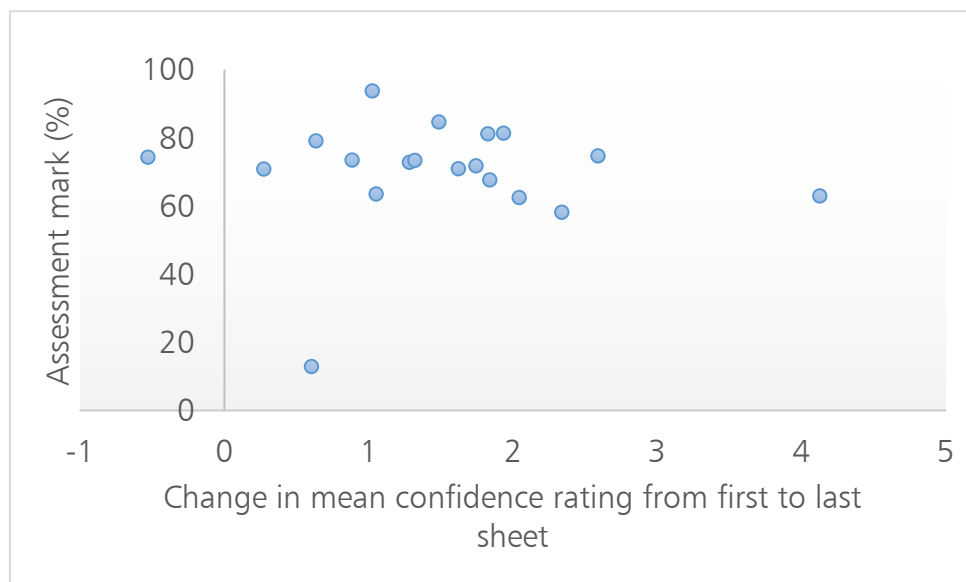


Fig 6: Correlation of change in mean confidence rating per student from first to last sheet with assessment mark.

The link between increased engagement with the tool and assessment outcomes may simply be due to a generally higher levels of engagement with their studies for those students in general and may not be the result of a beneficial effect of increased reflection as the Toolkit is intended to deliver. Therefore, to further investigate the link between student reflection with the Toolkit and attainment, the mean number of characters students had entered into the space for qualitative comment per Toolkit sheet were correlated against the marks attained. Interestingly, a significant negative relationship was found (Spearman’s rho = -0.448, P = 0.005; N = 37; Fig 7). Inspecting the plotted data it seems likely that this outcome is attributable mostly to an outlier value

for a student with a disproportionately high number of characters written (Fig 6). This outlier was more than 1.5. times the interquartile range (quartiles 1 to 3) from the upper end of quartile 3 and when excluded from analysis the relationship was no longer significant (Spearman’s rho = -0.155, P = 0.360; N = 36).

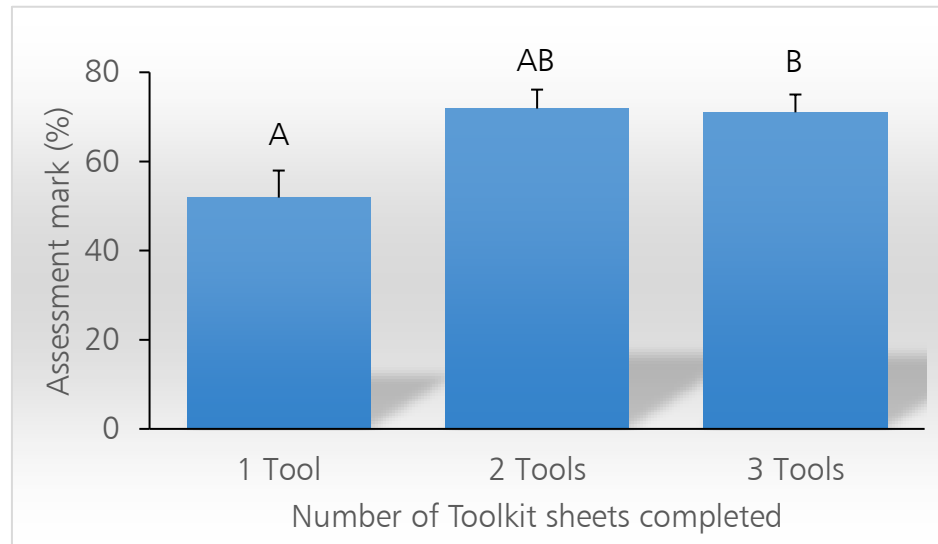


Fig 6: Mean assessment mark (+SE) achieved by students completing one, two or three of the Toolkit sheets for their project. Bars that do not share the same letter are significantly different from each other (Tukey’s post-hoc test, P<0.05). N= 13, 7, 18 respectively.

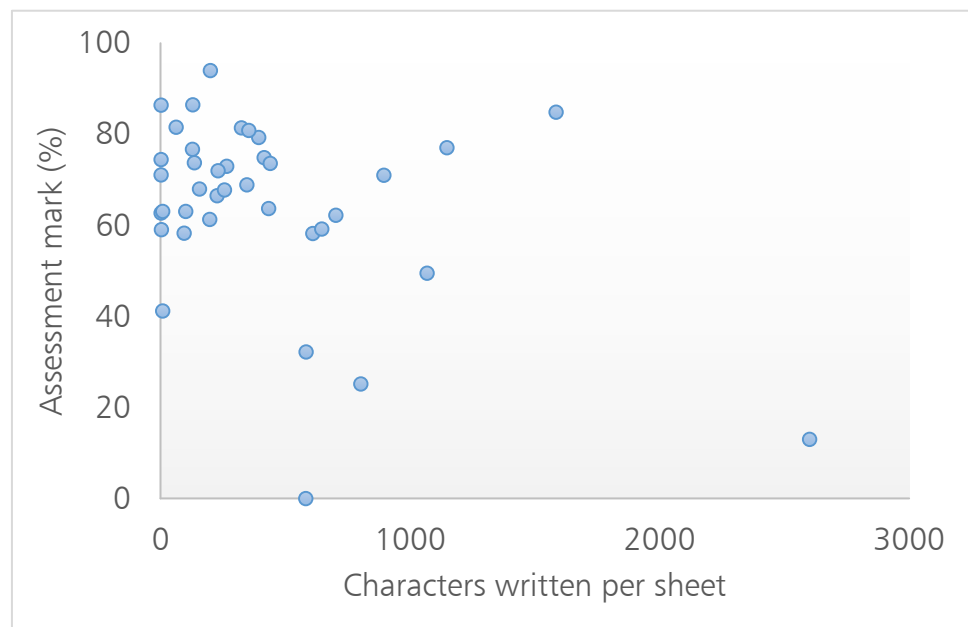


Fig 7: Correlation of number of characters written by students in space for reflective comment against assessment mark. N = 38.

The qualitative comments made by students about the skill statements often expressed directly or implied barriers to learning as well as enablers of learning. These were compiled into a list (Table 2) and will form a valuable resource for future curriculum development and course delivery as many of these barriers and enablers were common among students and therefore can be addressed proactively by adopting approaches to teaching that scaffold where barriers exist and reinforce enablers.

Table 2: Barriers to learning and enablers to learning as expressed by students in the space provided for qualitative comments on the Perception of Challenge Tool.

Barriers	Enablers
Lack of experience	Confidence
Lack of confidence/skill/ability	Receiving Guidance/Support from lecturer/technician/instructor
Learning disability	Guidance/review from peers
General anxiety	Planning ahead
Fear of the unknown	Practice/ experience
Self-criticism	Individual research/study
Time management	Time
Past negative experiences	
Lack of motivation	
Social circumstances	
Lack of infrastructure/resources	
Social anxiety	

In summary, while the confidence rating and assessment data from the Toolkit sheets themselves only provide limited evidence of a direct and causal relationship between engagement with the Toolkit and improved attainment in the assessment, there was evidence of the Toolkit recording changes in student autonomy and confidence levels and identified for themselves and their tutors a number of barriers to learning as well as enablers of learning.

Student evaluation and feedback

Of the students who completed a questionnaire about their experience with the Traffic Lights Toolkit in this module (N=28), a majority expressed positive views towards the Toolkit and its benefits for them (Fig 8). For example, approximately 85% of responding students agreed that the Tools had helped them to identify areas where they needed support. Approximately 90% of students agreed that the Tool had made them more aware of their role as an active learner, a key aspect of the Toolkit and one of the transferrable skills that were developed during this learning activity. 72% of respondents agreed that the Toolkit should remain part of the online log book assessment and the module as a whole (Fig 8).

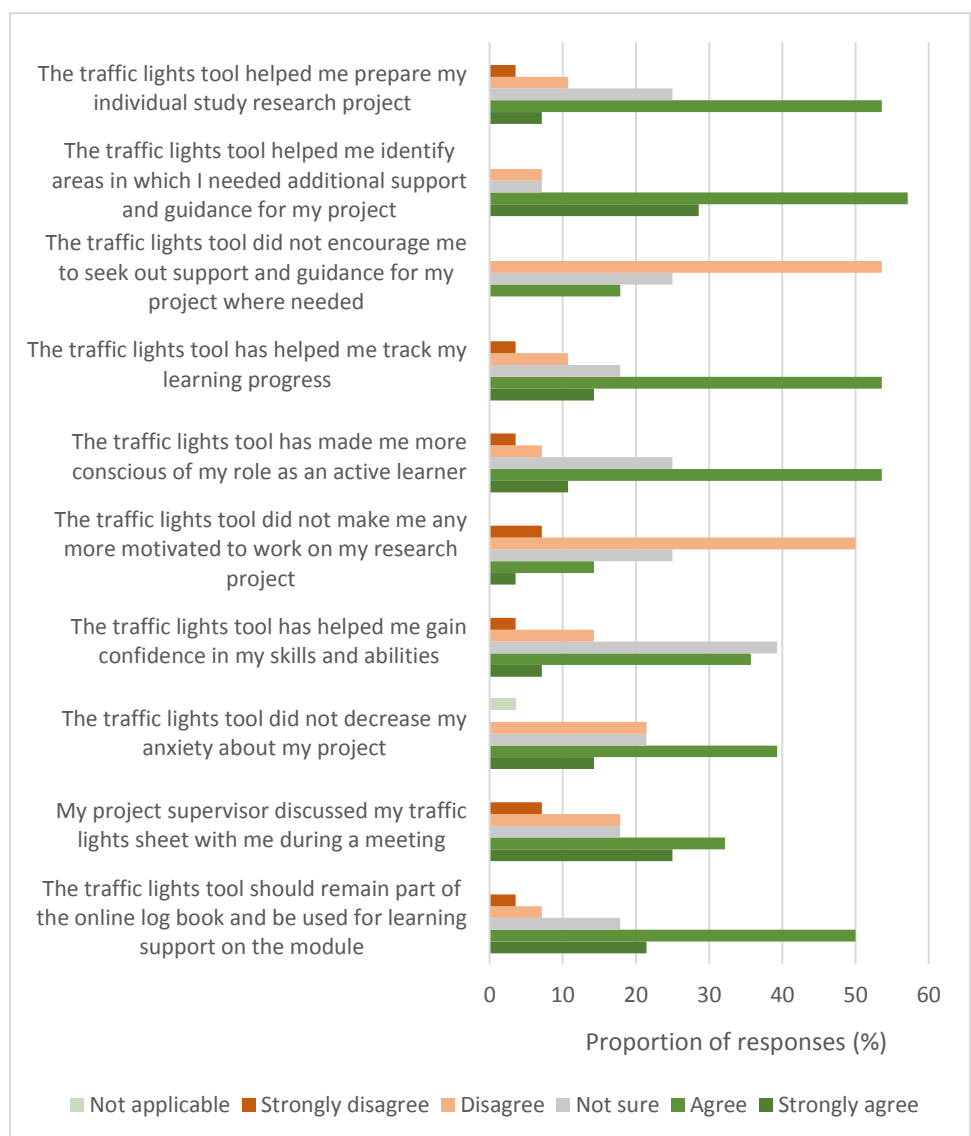


Fig 8: Student responses to questionnaire evaluating their experience with the Traffic Lights Toolkit. (N = 28)

One of the main aims of using the Traffic Lights Toolkit is to help students manage and reduce anxiety by taking ownership of their learning and starting with a sense of confidence based on skills they already have at the beginning of a learning experience. While the majority of students completing the questionnaire reported reductions in anxiety thanks to the Toolkit (e.g.: "I found the tool helped increase my confidence and motivation when looking back at it."), five of the students completing the questionnaire reported, that completing the Toolkit had increased their stress. This seemed to be primarily associated with the fact that it presented them with the large amount of learning expected of them over the coming year. One student commented: "Didn't help with confidence, just showed how much work needed to be done at the beginning of project, increased stress." To address this concern, the new iteration of the Toolkit that is being used with the 2018 cohort has been modified accordingly: The number of skill statement on the first sheet to be completed has been reduced to eight. Also, where previously the skill statements included some that related to skills not required until the very end of the module (i.e. almost a year on from the first sheet being completed), all of the eight statements are related to the preparation phase of the project. This will make the tasks ahead seem less overwhelming for students and will hopefully remove any cause for additional anxiety.

In the questionnaire, students were also given space to expand comment on any positive or negative responses they had given and suggest changes and/or improvements to the Toolkit. The themes that emerged from these comments matched those identified in the other case studies on the Traffic Lights Toolkit, e.g. in Allied Health. The comments indicated that the Toolkit had helped students to externalize their perception of themselves and their learning (e.g. "It helped me track my progress and helped me isolate the areas I found weakest"). They reported a perspective shift as a result of this externalization (e.g. "Discovering what I was/wasn't confident helped me more than I realized."). The Toolkit encouraged them to sort and map their abilities and learning needs ("Helped me plan out next steps and found it useful to take sheet to my supervisor and get help with part in red."). This process ultimately resulted in an intrapersonal change (e.g.: "Helped me spot the area where I need more work and work to improve them. TLT encouraged me to improve my skills and motivate me more."). Some students also made some interesting suggestions for improvements to the way the Tools were used, e.g.: "Perhaps more stress on how to use to your advantage. Maybe compulsory session to fill it in with supervisor present."; "Maybe group sessions on different areas and how to work on them." Students also saw the transferability of the Toolkit and the skills it was intended to develop for their studies in general: "It could be used at the start of the year for work in general rather than just the individual study. It makes students think about it in all aspects."

Outlook	<p>Large amounts of data and student responses originated from this case study and provide opportunities for extensive further analysis and interpretation. This analysis will continue into the future and will inform future iterations of the Toolkits and its use.</p> <p>Given the positive feedback for the Toolkit reported by students and the positive impact it had on student learning and encouraging reflection in students, the Toolkit is again being used with the current cohort of students preparing for their dissertation project at Canterbury Christ Church University. Some modifications have already been made (see above) in response to student feedback and the Toolkit will be reviewed after use with the current cohort for further improvements.</p>
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