Students at the centre of a virtuous circle: effective minimalist training through strong staff-student partnerships

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Abstract

Active learning has been shown to be effective in several knowledge areas and with participants from novices to experts in the field being studied. Within the field of IT training, the principles of minimalist training complement the tenets of active learning to put the user (or learner) at the centre of learning design and to encourage active, exploratory behaviours in the creation of knowledge and competence. Despite this, guided or directive training is still a common mode for taught or self-study interventions for developing digital skills.

This research examines whether a combination of minimalist instructional design and existing staff-student partnerships could create a more engaging, successful and cost-effective training programme compared to the previous guided training programme. The results show that not only did the minimalist design improve participant satisfaction and engagement, but the role of the Student Training Advisors became an essential element of the programme's success, mitigating or eliminating several of the potential difficulties of designing effective minimalist instruction and strengthening some of the key elements that make it effective.

Introduction

Active learning, in which students actively participate in the process of creating knowledge and mastering skills, has been shown to be effective in several knowledge areas and with participants who are novices or experts in the field being studied (Keith *et al.*, 2010; Weaver *et al.*, 2018; Wielenga-Meijer *et al.*, 2011). Within the field of Information Technology (IT) training and development, the principles of minimalist training and instructional design complement the tenets of active learning to put the user (or learner) at the centre of learning design and to encourage exploratory behaviours in the creation of knowledge and competence (Carroll, 1997). While many technical training courses continue to rely on guided or directive training techniques (such as instructor-led demonstration and 'follow along' practices, or through self-study via detailed manuals outlining the steps to take for successful completion of the task), several studies have found that active/exploratory learning is more effective in adaptive learning, defined as the ability to apply knowledge and skills in novel contexts (Keith *et al.*, 2010; Ginns, 2006). Since Carroll first published his thoughts on minimalist instructional design, the key principles have been adapted in different contexts to develop the most effective combination (see common applications in Table 1). For example: the level and type of autonomy and exploratory behaviours have been tested to find the most effective balance (Wielenga-Meijer *et al.*, 2011; Köppe and Rodin, 2013; Weaver *et al.*, 2018); templates for providing the appropriate amount of structure have been proposed (Carroll, 1997; Rodin, 2012); and the cognitive and emotional impacts of error training have been explored (Frese *et al.*, 1991).

Five minimalist principles (Carroll, 1997)	Common application in learning development or delivery
1. Allow learners to get started fast	Minimal instruction, demonstration, or documentation Activity-based learning
2. Rely on people to think and to improvise	Encouragement of autonomy and exploratory behaviours
3. Embed information in real tasks	Tasks or activities based on the learner's context or real-world situations
4. Take advantage of what people already know	Use of metaphor or analogy Connection to other pre-existing knowledge or conceptual understanding
5. Support error recognition and recovery	Anticipating and managing errors, turning them into learning opportunities (sometimes referred to as 'productive failure')

Table 1. Common applications of minimalist training principles

In 2014, the London School of Economics and Political Science's (LSE) IT training team set out to determine whether a combination of minimalist instructional design, active learning principles and better utilisation of existing staff-student partnerships could create a more engaging, successful and cost-effective training programme than the previous guided training programme. The new programme's success would initially be evaluated on measures of student participation, since the previous programme was experiencing declining participation despite high satisfaction. It would also be evaluated against participants' self-reported success at subsequently applying the skills in their own work (adaptive learning).

Following the initial pilot, the team identified several other interesting and positive changes amongst the standard feedback collected, such as higher participant satisfaction and greater analogic and adaptive learning as observed by the staff. These changes have been tracked over subsequent years and are presented here, although they were not the initial outcomes the team sought to measure. Results achieved by applying minimalist principles to session design in the pilot period and following year have been repeated in subsequent years, allowing the LSE training team to deliver high-quality, enjoyable and effective training at a lower cost than the guided self-study model.

In addition, the team was delighted to discover additional, unanticipated positive results stemming from the strengthening of the student-staff partnership between the professional training team and the Student Training Advisors (STAs), whose expanded role in the process developed organically. Whereas the STA role had previously focused on administration and troubleshooting in the self-study sessions, the pilot of the new format required a more active coaching approach by the students to ensure learner progression and achieve effective error recognition and recovery by participants. Over the years following the pilot, the input of the STAs – regarding both workshop content and how best to support the

participants – has refined both the workshops themselves and the support and training provided to new student trainers. The STAs became an essential element of the programme's success, mitigating or eliminating several of the potential difficulties of designing effective minimalist instruction and strengthening some of the key elements that make it effective. Their contribution has made the LSE IT Practical programme an excellent example of how strong student-staff partnerships support digital skills development in the current era of rapid technological change.

Methodology

This paper compares the qualitative and quantitative data collected from two different delivery formats for the training programme in Microsoft Office. Post-course evaluation forms that were completed by participants at the end of each session were examined to evaluate satisfaction and engagement. Additionally, three weeks after attending a session, participants were asked to report on their success at applying the taught skills within their own work. Data from these forms were used to evaluate effectiveness of learning transfer (Kirkpatrick *et al.*, 2009). Attendance, participants' qualitative feedback and financial data were reviewed to identify trends in participation – and therefore engagement[1] – and the financial viability of each format[2]. Email interviews with former STAs were conducted to understand the student trainers' perspectives on what made the programme effective and what role they played in the programme's success.

LSE delivered guided training exclusively through a 'self-paced workshop' format between January 2006 and January 2014. In self-paced workshops, up to fifteen participants worked through instructional booklets, consisting of step-by-step instructions for completing a series of related tasks in a single piece of software. For example, a one-hour session in Excel, covering Formulas and Common Functions, consisted of twenty tasks which progressed in stages to cover the complete topic. The sessions were supervised by one or two STAs, whose role was to ensure accurate and smooth administration of the session and to support participants in successfully completing the workshop, primarily through troubleshooting incorrect application of the outlined steps. The training team had noticed a decline in participant engagement over the years (based on declining participation and lower repeat attendance), which subsequently increased the cost per attendance and cost per head of running the programme. Furthermore, based on their own observations within class and feedback from the STAs, the team concluded that the courses were ineffective at both analogic and adaptive learning (Keith *et al.*, 2010).

As a result, a new model of training, called IT Practicals, was piloted in January 2014 (Lent term) and fully replaced the guided training model in the 2014-15 academic year. The IT Practical Workshop model provides participants with a small project or task requiring a variety of techniques and the application of technical and non-technical knowledge. The task describes desired outcomes but not the specific steps necessary to achieve them –

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[1] Of course, participation alone does not equal engagement. Therefore, the authors have looked at participation figures (both total numbers of participants and the number of repeat attendance by a single participant) and the content of qualitative feedback to make judgements about participant engagement.

[2] The authors want to thank Ms Nina Keleher, Training Team Administrator at LSE, for her work on data collection, cleaning, and initial analysis. They would also like to thank Dr Jim Tyson, Senior IT Trainer at UCL, for his advice and feedback on the methodology and findings.

intentionally to mimic how a task would be assigned in a workplace context. Where appropriate, constraints are introduced to guide the participant to the discovery of particular tools or techniques (for example, one task indicates that the optimum number of formulae to use is three, to encourage the use of mixed and absolute references). Participants are encouraged to apply their existing knowledge, to collaborate with other participants, to explore and experiment with the software and to use online searches to discover how to complete the task. In the final ten to fifteen minutes of the hour, participants are provided with the 'suggested solution', which details which formulae or tools the 'expert' training team recommends for completion of the task. The solution is only suggested, as any use of tools or techniques which allows accurate completion of the task is considered legitimate in learning to use the software. For the participants, the suggested solution allows for reinforcement of and reflection on their learning, as well as introducing alternative techniques they could further explore in the remaining time or subsequent use of the software.

The IT Practical format met all five minimalist training principles outlined by Carroll by allowing participants to start quickly on the task by cutting down on expository text (principle 1). As the task was a complete mini-project rather than disparate single examples strung together, it was situated in a real-world context (principle 3). Participants were encouraged to apply their existing knowledge (principle 4) and ability to reason while exploring the software in the completion of the task (principle 2). Finally, coaching by the STAs and encouragement to undertake online research, followed by a suggested solution for comparison, allowed for successful error recognition and recovery (principle 5) (Carroll, 1997). Reflecting on data from the pilot year through to 2016-17, four main hypotheses were tested: that participant satisfaction would be higher with the IT Practical format; that participant engagement, both as a proportion of the total population and for individuals, would be higher with the IT Practical format; that the IT Practical format would result in greater analogic and adaptive learning transfer; and that a need for more staff resources to deliver the courses would be offset by greater application of the service.

To test the hypothesis that the new format would elicit greater participant satisfaction, the authors compared post-course evaluation satisfaction scores from Lent term 2014 (the period of the initial pilot of the new format), during which time the same topics were covered in both formats and participants could choose between the two formats based on their interest and availability. For the pilot, content from two self-paced workshops was reworked into the new IT Practical format, creating three pilot courses[3]. The 'Excel 2010: Formulas and Common Functions' course was renamed 'Excel 2010: Numeric Calculations' in the new format. During the pilot period we ran twenty-three sessions in the old (control) format, and twelve in the new format. Average attendance at both formats was roughly similar, with an average of 2.3 participants for the control format and 2.08 participants for the new format. The 'Excel 2010: Logical and Lookup Functions' course was split to create two IT Practical courses, entitled 'Excel 2010: Lookup Functions' and 'Excel 2010: Complex Calculations'. On this set of topics, we ran nineteen sessions in the control format with an average

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[3] Not all content from the two courses was included in the new format, as it was expected that an exploratory approach would require more time to complete than the previous guided approach. Therefore, the IT Practical courses covered the key learning objectives, but did not cover all the detail or additional options that were available in the self-paced workshop courses.

attendance of 1.42 participants, and twenty sessions in the new format with an average of 1.45 participants (see Table 2).

Course	Courses Run	Total Attendance	Average Attendance
Excel 2010: Formulas and Common Functions	23	53	2.30
Excel 2010: Numeric Calculations	12	25	2.08
Excel 2010: Logical and Lookup Functions	19	27	1.42
Excel 2010: Lookup Functions IT Practical Excel 2010: Complex Calculations IT Practical	20[4]	29[5]	1.45

Table 2. Participation in control and pilot sessions

Given the small sample size, satisfaction scores for all Excel courses offered in Michaelmas term 2013 (prior to the pilot) and all Excel courses in Michaelmas term 2014 (when all Excel courses had been converted to the IT Practical format) were also compared to validate the results against a larger sample size[6].

To test the hypothesis that participant engagement would be higher for the new IT Practical format, attendance figures for Excel courses in Michaelmas term 2013 (the control group) and Michaelmas term 2014 were compared. Figures pertaining to the number of participants who attended multiple sessions were also compared, with the assumption that participants who attended a greater number of workshops were more engaged. Finally, text comments referring to the course format were coded as either 'Format – positive' or 'Format – negative' and the percentage of each was converted to a percentage of total comments for both the pilot and for Michaelmas term 2013 (self-paced workshop format) with Michaelmas term 2014 (IT Practical format). A combination of attendance figures and percentage of comments related to format formed the basis for evaluation of learner engagement.

To test the hypothesis that the IT Practical format would result in greater learning transfer, responses to the follow-up evaluation survey – sent to all participants two to three weeks after attendance at a session – were compared. Participants were asked whether they had applied the skills taught in the session and, if so, whether they: could apply the skills immediately; do so with some additional support; were unable to apply the skills. Owing to a low response rate, responses for all courses (including Word, PowerPoint and Outlook) across both academic years were reviewed. In 2013-14, thirteen responses were received (out of 298 attendances); in 2014-15, seventy-five responses were received (out of 718

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[4] Ten of each course were run.
[5] Lookup Functions had seventeen attendances; Complex Calculations had twelve attendances. Of those twelve participants, ten had also attended Lookup Functions.
[6] For the self-paced workshop format, ninety-three evaluations were received for this period, representing a return rate of 44%. For the IT Practical format, 482 evaluations were received for this period, representing a return rate of 75%.

attendances). While none of the responses received for 2013-14 were for the IT Practical sessions, all responses for 2014-15 were, allowing a clear comparison of the two formats.

The role of the STAs in participant engagement and learning transfer could not be directly measured through a reflective evaluation of the course feedback. Comments about the STAs were largely positive across the years, but there was little detail within the comments about the specific role of the STAs in the learning process in the pilot year. Since that time, specific comments about the impact of the STA on the learning experience have been more common[7]. The authors can therefore only hypothesise that the lack of specific commentary on the role of the STA in the pilot year indicates a weak correlation while the increase in number and specificity of comments in subsequent years indicates a higher correlation between the role of the STA and participants' engagement and satisfaction.

To test the hypothesis that a need for more staff resources to deliver the courses would be offset by greater use of the service, the total amounts spent on STA salary costs in 2013-14 and in subsequent years were compared, calculating the cost per attendance and cost per individual for delivery of the training programme.

Findings

Hypothesis 1: Participant satisfaction will be higher with the IT Practical format

During the pilot period, participants in both the older, guided method and the newer exploratory method were satisfied with the training they received, as no evaluations were returned with participants reporting they were 'dissatisfied' or 'very dissatisfied'. For the old format, equal numbers of participants reported being 'satisfied' and 'very satisfied' (at 47.37%). With the new IT Practical format, the number of participants reporting they were 'very satisfied' with their training experience rose to 81.08%. Although overall satisfaction (as a combination of both 'satisfied' and 'very satisfied') responses was not significantly different amongst the pilot group, higher individual satisfaction (as a proportion of responses in the 'very satisfied' category) was found with those participating in the new IT Practical format (see Figure 1).

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[7] For example, a comment from the week commencing 3 December 2018 states *"Joon has been very supportive and patient. He gave me all the attention I needed and I never felt left on my own (although he never gave away the answers to any task)"*. Specific comments such as the above are received on a weekly basis.
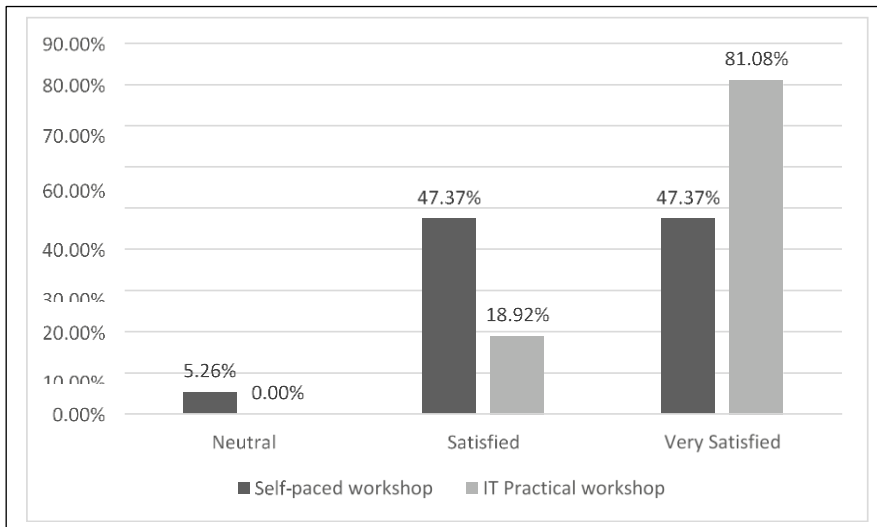
Figure 1. Satisfaction rates of Self-Paced vs IT Practical sessions

To verify the results beyond the small sample size of the pilot, satisfaction rates in the self-paced Excel courses in Michaelmas term 2013 were compared to satisfaction rates in the IT Practical Excel courses in Michaelmas term 2014. A similar pattern emerged, with overall satisfaction with the programmes being similar (90.32% in the control and 96.68% in the new format), but with a much greater proportion of participants reporting they were 'very satisfied' in the new format (40.86% in the control and 64.52% in the new format; see Figure 2).
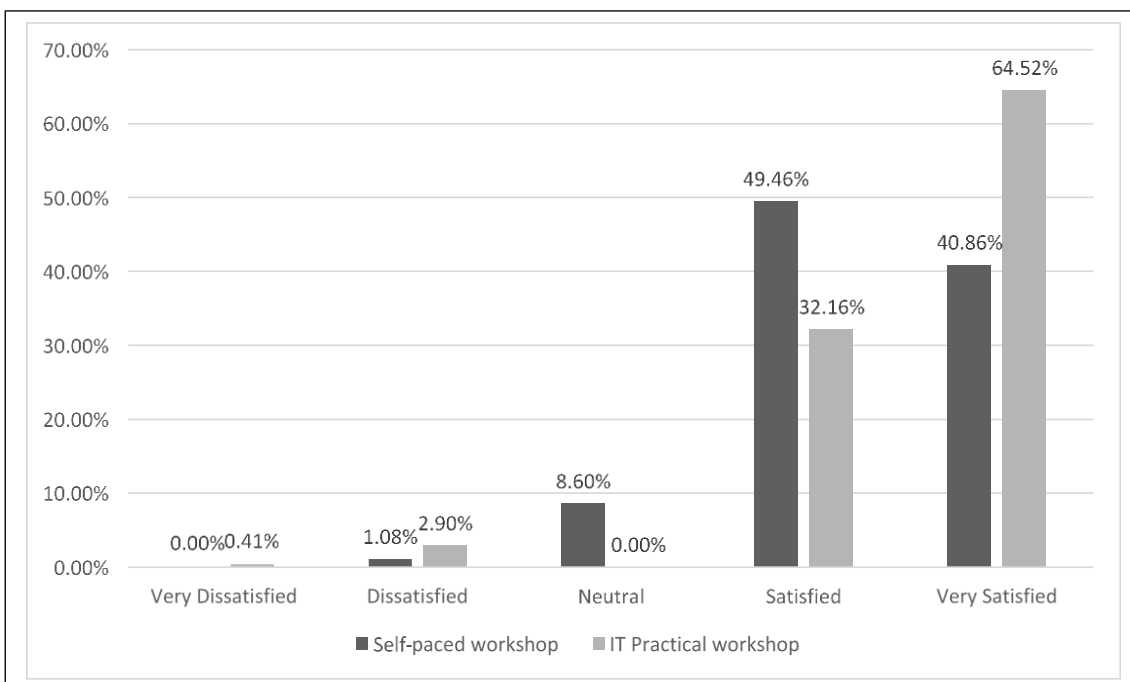

Figure 2. Satisfaction rates of Excel courses in self-paced format, Michaelmas term 2013 vs IT Practical format, Michaelmas term 2014

A high proportion of 'very satisfied' responses has persisted in subsequent years for courses taught in the IT Practical format, with 'very satisfied' responses ranging from 75.71% - 80.05% of the responses in a year, and 'satisfied' ranging from 19.08% - 23.14%.

Hypothesis 2: Participant engagement with the learning process will be higher with the IT Practical format

The number of available training sessions in Michaelmas 2014 increased by 10% (compared to the same period in the previous year), but the team saw an increase of 206% in attendances and an increase of 99% in the number of individuals attending (see Table 3).

	Self-paced workshops (MT 2013)	IT Practical workshops (MT 2014)	Percentage change
Courses run	119	131	+10.08%
Total attendance	209	641	+206.70%
Individuals attending	118	235	+99.15%

Table 3. Comparison of participation in old (control) and new format of Excel courses

While other factors might explain an initial increase in attendance, such as changes to publicity or an interest in a new/changed service, the trend for increased attendance continued in subsequent years, with an increase in attendance from 1841 in 2014-15 to 2405 in 2015-16 (30% increase) and an increase in the individuals taking part in the programme from 428 in 2014-15 to 577 in 2015-16 (35% increase).

Repeat attendance at sessions was also compared, to determine if more individuals voluntarily participated in more training in the new format (see Table 4).

	% of total individuals	MT 2013	MT 2014	% of total individuals
Individuals attended 1 Excel workshop	61.02%	72	103	43.83%
Individuals attended 2 Excel workshops	18.64%	22	38	16.17%
Individuals attended 3 Excel workshops	11.02%	13	27	11.49%
Individuals attended 4 Excel workshops	5.08%	6	21	8.94%
Individuals attended 5 or more Excel workshops	4.24%	5	46	19.57%

Table 4. Repeat attendance at Excel courses in Michaelmas term 2013 and Michaelmas term 2014

Significantly, the percentage of participants who attended five or more sessions increased from 4.24% to 19.57% in the new format. This upward trend in people attending several workshops has persisted year after year (see Figure 3).
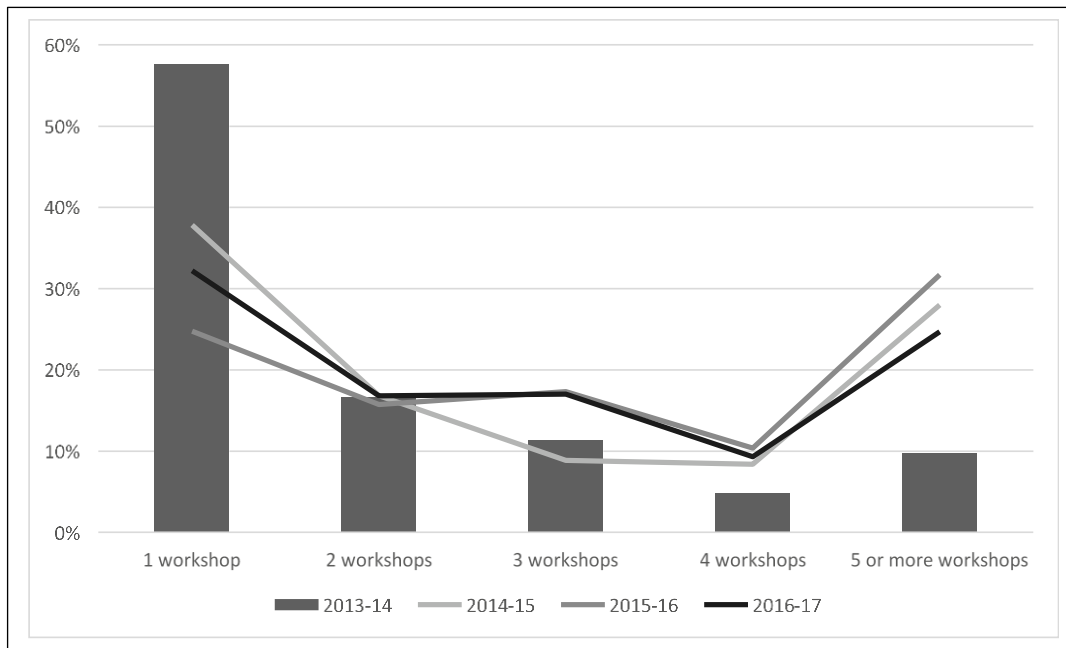

Figure 3. Percentage of individuals attending one, two, three, four, and five or more sessions in a year

The increased attendance, coupled with the increase in percentage of participants who elect to come to several sessions, suggests that participant engagement in the learning environment is higher with the new IT Practical format.

A review of qualitative feedback shows a greater number of positive comments for the pilot courses (54.05%) than for the self-paced workshop courses in the same period (21.05%). This may be explained by the desire to comment on what is new and different. For the period prior to the pilot (Michaelmas 2013) and the same period in 2014, respectively 16.35% and 16.97% of comments were positive statements about the format. To understand further the possible reasons for increased attendance, a deeper review of the content of the comments may elicit more information about the effectiveness of the formats, as some comments focused on enjoying the self-study aspect, which is present in both formats, and others reflected more deeply on the adaptive aspect of learning experience, which is present only in the newer IT Practical format:

"I liked how we had to do it ourselves rather than being led through it. As this is the way one does it in reality!" – pilot participant feedback

A criticism of unguided instruction is that it can result in incomplete knowledge and/or ineffective learning through unproductive search (Kirschner *et al.*, 2006). Taofiq Akinpeju, an STA in 2015-16, felt the format was encouraging and empowering, but that the STA played a key role in tailoring the independent approach for those who found the lack of directive instruction more challenging:

"It's empowering, the 'have a go' culture definitely pushes them into problem solving mode. And for those that start from Calculated Worksheets [the first course in Excel] and work their way up, they get enough success and brownie points that it allows them to stick with it when the harder workshops come along."

For staff, not all are very keen to do sessions independently, so this positive for this group of attendees might actually feel like a negative.

"*With a capable STA who know their content however, the approach can be tailored to work for all capabilities.*" – email correspondence, December 2018

The tailoring of approach undertaken by the STAs supports two key principles of minimalist training by allowing STAs to understand and then tailor their support based on what participants already know (principle 4) and provide the right level of support for effective error recognition and recovery[8] (principle 5).

Hypothesis 3: The IT Practical format will result in greater analogic and adaptive learning transfer

Follow-up evaluations are sent to all training participants two to three weeks from the date of attendance, requesting information about whether they have attempted to apply the skills taught in the session to their own work. Those who have attempted to do so are asked whether they have been able to do so easily, with additional effort and/or help, or have been unsuccessful. In 2013-14, there was an extremely low response rate to this questionnaire, which was only slightly improved upon in 2014-15. In 2013-14, 85.72% of respondents were successful in applying the skills, while in 2014-15, 98.24% of respondents were successful (see Table 5).

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[8] This is also one of the key distinctions between minimalist training for technical skills and problem-based or constructivist learning in academic disciplines criticised by Kirschner. Focusing on the cognitive load experienced by novices, Kirschner posits that unguided instruction prevents the creation of long-term memory, which is central to mastery of a subject and productive learning. He states it is important to provide novices "with extensive guidance because they do not have sufficient knowledge in long-term memory to prevent unproductive problem-solving search". While there isn't space to debate the number of ways minimalist training and the particular implementation of this method by the LSE differs from the models criticised in Kirschner's paper, the role of the students in tailoring and facilitating skills development in error recognition and recovery is perhaps the fundamental difference, in that it ensures productive failure rather than unproductive problem-solving search.

	% of responses where participant attempted to apply skills	% who applied skills with no additional help	% who applied skills with some additional help and/or exploration
2013-14	7	42.86%	42.86%
2014-15	57	61.40%	36.84%

Table 5. Percentage of participants who were successful at applying learnt skills 2-3 weeks post-course

In subsequent years, the response rate of follow-up evaluations improved[9], resulting in more confidence that the IT Practical format resulted in both analogic and adaptive learning, with between 92%-100% of respondents successfully applying their skills after the course.

Hypothesis 4: A need for more staff resources to deliver the courses will be offset by greater utilisation of the service

In the self-paced workshop format, a single hourly-paid STA was required to supervise courses, with a second member of staff added if the course had eight or more bookings (maintaining a ratio of no more than eight students to one STA). The pilot of the IT Practical format demonstrated that the participants would require more engagement from the STA and that a much lower ratio would be required. Experimentation during the pilot determined that four students to one STA was optimal for this format. In addition to an increase in the number of staff required for each session, more induction and support was required for the STAs to ensure they could undertake their expanded role effectively.

During the pilot period, the role of the STAs was not explicitly changed; their role continued to require administration and support for the students to complete the task. However, the balance of skills they deployed did shift, with more emphasis on coaching and support for online research being required in the new format, and this has continued to expand over the years. In the self-paced workshop format, STAs took a more passive role and waited for participants to request help. In the IT Practical format, STAs are proactive, evaluating prior knowledge of all participants individually as they arrive, framing the workshop format for participants who have not previously attended a session, actively monitoring progress and using guided questioning to ensure a balance of exploration, productive failure and progression and tailoring their approach to the needs of each participant, providing more or less support as needed. These developments occurred naturally over time, as the STAs shared their experiences with each other and the professional training team.

Following the pilot, STAs were brought in to share their experience and make suggestions for improvement. These feedback sessions have continued on a termly basis, with STAs providing suggestions for new courses, updates and improvements to the existing courses (based either on participant feedback or their own experiences in internships and volunteer

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[9] In 2015-16, 399 responses were received, representing a 17% return rate. In 2016-17, 707 responses were received, representing a 33% return rate.

work), engaging in peer learning by sharing examples of good practice and engaging in joint problem-solving, and developing, independently or with the support of the administrator, more efficient administrative procedures. For example, STAs quickly discovered that participants progressed more effectively if they dealt with just one STA during the session and that 'splitting the room' meant the STAs could more easily track progress and support the learners' construction of knowledge throughout the hour. They have identified common problems (such as lack of mathematical understanding amongst certain cohorts) and shared methods for supporting these learners. The 2015-16 cohort improved administrative functions by setting up a WhatsApp group to swap shifts more easily, cutting down on emails and missed messages.

Aastha Arora, STA from 2015-17, detailed the contributions made by STAs to the continuous improvement of the programme:

"After one year's experience of teaching, we took the initiative to interview/guide/train the new STAs – pass on our own teaching tricks, assist [professional staff] in the induction process, [creating a] much more efficient induction program in terms of management resources. STA end of term feedback meetings [were] a useful meeting to improve IT teaching program and personal development for STAs. Opportunity for us to contribute to: Brainstorming new content, feedback on teaching style, issues with structure (teaching and admin aspects)." – email correspondence, December 2018

The increase in staff numbers, in addition to more hours for induction and feedback sessions, meant the total programme costs increased. However, increased participation and repeat attendances meant the cost per participant was reduced. In 2013-14, the programme cost £17.77 per attendance or £36.52 per individual trained. In 2014-15, the programme cost £8.36 per attendance, or £27.62 per individual. In each year since, the total cost the programme has increased, but the cost per attendance has remained between £8.36 and £9.22 and the cost per individual has remained between £27.62 and £32.97. Thus, while the overall cost has increased, the cost per participant and per attendance has remained lower than it was, delivering a superior offering at lower cost per person.

Discussion

The data provide evidence of the expected improvements in participant satisfaction and engagement, although this paper's context is one of reflection on several years' experience with the format and therefore the data presented was not initially collected to evaluate the hypotheses above. Consequently, there are some areas where further, more dedicated research into the effectiveness of the programme would be valuable, particularly as it relates to learning transfer. Improvements in response rates, combined with a method of assessing the learner's existing knowledge before training as well as her/his success in applying learning during and after training, would yield more interesting results about the effectiveness of the model.

Furthermore, participants in the training programme are a self-selecting group who attend for varying reasons – one of the most common objectives cited is the desire to improve general IT skills. For example, in 2016-17 only 3.41% of respondents indicated they attended to assist them in their coursework or their current job. By comparison, 74.65% of respondents attended to improve their IT skills/for general interest. As a result, the majority of participants

may have fewer opportunities to apply the skills learnt in the session, unless they seek out such opportunities to cement their knowledge or they attend another session in which they can reinforce their previous learning. This reduces the sample size for assessing the effectiveness of the programme for learning transfer and raises the question about how to assess whether the current programme meets participants' stated objective of general skills improvement.

Perhaps most crucially, it would be interesting to conduct A/B testing to understand fully and appreciate the effect of the STAs in the success of the training. Though we can state how their role has changed and demonstrate that the programme has become more successful and effective, we cannot on the current data determine the exact size of their impact. So, while we expect – on the basis of experience and observations – that their role is fundamental and key to the success, we cannot demonstrate this with data.

As previously mentioned, comments were evaluated regarding whether they were positive or negative about the format, but no further analysis of the content of the comments was undertaken. Further analysis in this area, both for the pilot and over time, may elicit more interesting insights into the participants' experiences of the format. For example, during the pilot period, we received fifty-one positive comments about the new format, some of which specifically identified the key principles underpinning minimalist training. In response to the prompt "I really liked...", participants identified each of the five principles of minimalist training as a positive:

Minimalist principles	Samples of participant feedback
Allow learners to get started fast	• The situational based training • The fact you are made to do the work yourself and you are left to your own devices
Rely on people to think and to improvise	• The fact it wasn't completely tutored but we were left to learn by hit & trial initially • Self-learning - allows you to think & ask for help if necessary • The challenge, the hidden complications not immediately apparent
Embed information in real tasks	• How all techniques previously used were incorporated and the relevance of the courses to the real world
Take advantage of what people already know	• I had to think and try to resolve problems on my own, so I put into practice what I learnt in previous workshops
Support error recognition and recovery	• To work in small groups - resolving problems it's the only way for me to understand what I am doing • Guidance (getting 'patient' [sic] coached to a solution)

Table 6. Participant feedback as it relates to key minimalist principles

By contrast, the majority of positive comments received about the previous self-paced format identified the ability to work independently (a characteristic of both formats) and the provision of a step-by-step booklet as key factors. The second factor is interesting and did not disappear with the new format when the step-by-step guides disappeared. Over the years, a small number of participants has expressed dissatisfaction with the IT Practical format and the main reason cited is a preference for more direction or guidance. In one notable example, an email was sent to the training manager to complain that the IT Practical format was not suitable for all learning styles. Carroll and his colleague van der Meij address this in *Ten Misconceptions about Minimalism*:

"*In our user-centred approach it has, however, never been our chief intention to 'merely' please learners. Users do not have to love the manual in order to learn from it. They have to accept it to the extent that they use it effectively; people's meta- knowledge about their own information needs is often flawed. Thus we have, over the years, encountered users who voice the desire for more complete manuals, but we have weighed this misfit between their desires with the results we have obtained for learning outcomes, namely, that they learned more than their peers who used more complete manuals.*" (Carroll and van der Meij, 1996)

Given users' flawed knowledge about how they best learn, it is necessary to evaluate all participant comments carefully to separate constructive criticism from statements of dislike or discomfort which can be acknowledged with empathy and counter evidence. If the participants can be pleased, all the better. But the first guiding principle is to serve them effectively. Therefore, further research that compares the content of negative comments about the format, measured against the learning transfer achieved during the session, would be interesting.

An unexpected outcome of the programme has been the change in the role of the STA and the impact of that change on the programme. This change is less easy to quantify and measure but has been validated by several cohorts of student adviser and is the considered experience of the professional training team at LSE. It was quickly discovered in the pilot session that the existing arrangements for student staff would need to change, requiring a higher staff-to-student ratio as more support and coaching of participants was required. So, while the initial goal was to determine if the change of format along with better application of the existing student-staff partnership would result in greater participation and lower costs, it was subsequently found that the student-staff partnership was integral to achieving optimal results. This process happened organically and was primarily led by the students themselves, which resulted in a virtuous circle of improvements, with the student trainers at the centre.

A key element of minimalist documentation and training is the support for error recognition and recovery, which often takes the form of anticipating where errors might occur and ensuring they do not derail the user from the task at hand. This can be done through documentation, through the creation of specific software, or through the training environment. In the IT Practical format, this is achieved through the role of the STAs. While the role of the STA had always been to support students when they encountered errors, the more open-ended, task-focused and exploratory nature of the new IT Practicals changed the form the error recovery took. Rather than reviewing the steps taken to identify which of the workbook instructions had been missed or misapplied, STAs now took on a coaching role, working alongside the participants to understand their thinking process and what solutions

they had attempted and then redirecting them to a more fruitful path, encouraging and guiding their further exploration through online resources or experimentation with various tools. The skills of the STAs, both technical and communicative, were key to providing a supportive but open environment for exploration. All STAs received training in open-ended questioning techniques and were then encouraged to discover their own style of support and ways of guiding individuals through error recovery. All STAs are expected to be proactive in observing the participants and assessing when to step in and when to let them struggle towards their own understanding. This evaluation of productive and non-productive errors is key to a successful learner experience:

"*Errors are not homogeneous. Some errors immediately intrigue learners; they wonder what caused the error; they want to replicate it, to analyse it, to try variations. These are good candidates for which to encourage error diagnosis and recovery.*

Other errors, just as clearly, annoy users from the first keystroke to the final recovery. When the frustration experienced by a learner obstructs the possible insights, the error recovery can no longer be seen as productive." (Carroll and van der Meij, 1996)

In minimalist documentation, the identification and handling of errors are done at the point of creation, then validated through user testing. As previously described by Taofiq, the presence of the STAs in the classroom has allowed tailored error recovery to take place, in response to the skill, prior knowledge and motivation levels of each student. Common errors are quickly identified by the STAs and anticipated in future sessions and/or fed back to the team for modification of the materials. Errors which are specific to individuals are then handled as they occur. As in most research on error recovery, the goal is not to prevent frustration, but to equip the users to deal with the frustration effectively (Frese *et al.*, 1991). When asked what made the sessions effective for participants, Tanim Zaman (STA from 2013-2015), replied "*they are not given solutions when they get stuck. They are skilfully guided to the right method by a questioning and logical reasoning method.*" The personal support provided in this way by the STAs affects the participants' experience in a positive way.

"*Advisors knew when to help and when to let you work it out for yourself, which encouraged independent learning without getting too stuck.*" – participant feedback, undergraduate student

This engagement with the learner has many advantages. Not only does it support error recovery, but it supports the principles of user-centred design and testing that are inherent in the theory of minimalist instructional design. As previously mentioned, it also allows for rapid, iterative improvements to the materials, based on both positive and negative feedback.

"*...minimalist learning materials should be developed through an iterative process, including usability testing at each stage with actual end-users. This approach helps to ensure a more learner centred approach, as designers' theories of the task domain and appropriate instantiation of minimalist design principles and heuristics are explicitly and repeatedly tested.*" (Carroll, 1997)

By engaging directly in observation of user behaviour and discussion of the learner's thought process, STAs are conducting mini-usability tests in every learning session. These insights

not only provide direct feedback for their work with other participants but are also fed back to the training team staff at termly sessions, which allows for rapid, iterative improvements to the programme and assists in successful omission of unnecessary information and appropriate clarification of the materials. On the positive side, participants bring their own knowledge to the sessions and engage in creative problem-solving, particularly as there is no 'correct' method, provided an accurate outcome is achieved. The STAs' role in observing this creative problem-solving behaviour has led on several occasions to an updated task or an improved 'suggested solution', where the approach taken by the participant is considered more effective, efficient or valuable within the learning context.

Therefore, the partnerships between the learners and the STAs and between the STAs and the professional training team staff are the key to the success of the programme and a unique implementation of minimalist principles. Through the strengthening of the staff-student partnership, a challenging, responsive, effective and enjoyable learning environment for digital skills development has been created and sustained. Given the rapid rate of change in the digital world – both in technologies themselves and in the methods and capabilities expected of our students – this student-staff partnership ensures an approach to training which is fluid flexible and responsive to change and input, and focuses on developing the skills to explore, evaluate and apply the capabilities of technology as it changes.

Reference list

Carroll, J.M. (1997) 'Toward minimalist training: Supporting the sense-making activities of computer users.' In: Quiñones, M.A and Ehrenstein, A. (eds.), *Training for a rapidly changing workplace: Applications of psychological research.* Washington: American Psychological Association, 303-328. ISBN: 978-1-55798-386-2

Carroll, J. and van der Meij, H. (1996) 'Ten misconceptions about minimalism.' *IEEE Transactions on Professional Communication,* 39(2), 72-86. Available at: https://ieeexplore.ieee.org/document/503271 (Accessed: 03 July 2018).

Frese, M., Brodbeck, F., Heinbokel, T., Mooser, C., Schleiffenbaum, E. and Thiemann, P. (1991) 'Errors in Training Computer Skills: on the Positive Function of Errors.' *Human–Computer Interaction,* 6(1), 77-93. Available at: https://www.tandfonline.com/doi/pdf/10.1207/s15327051hci0601_3 (Accessed: 05 July 2018).

Ginns, P.N.P. (2006) 'Meta-Analysis of the Minimalist Training Model.' *Online Submission,* 4. Available at: https://pdfs.semanticscholar.org/173c/fedfe81bf5c76afb6fad692f5b57bbd7f7a9.pdf (Accessed: 05 July 2018).

Keith, N., Richter, T. and Naumann, J. (2010) 'Active/Exploratory Training Promotes Transfer Even in Learners with Low Motivation and Cognitive Ability.' *Applied Psychology,* 59(1), 97-123. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1464-0597.2009.00417.x (Accessed: 05 July 2018).

Kirkpatrick, D.L., Kirkpatrick, J.D. and Kirkpatrick, W.K. (2009) *The Kirkpatrick Model.* Available at: https://www.kirkpatrickpartners.com/Our-Philosophy/The-Kirkpatrick-Model (Accessed: 05 July 2018).

Köppe, C. and Rodin, R. (2013) 'Guided Exploration: An Inductive Minimalist Approach for Teaching Tool-related Concepts and Techniques.' In: *Proceedings of the 3rd Computer Science Education Research Conference, CSERC'13*. Arnhem, Netherlands: ACM. Available at: http://koeppe.nl/publications/CSERC2013_Koppe.pdf (Accessed: 05 July 2018).

Rodin, R. (2012) Meta patterns for developing a minimalist training manual. In *Proceedings of the 19th Conference on Pattern Languages of Programs* (p. 15). The Hillside Group. Available at: https://dl.acm.org/citation.cfm?id=2831295 (Accessed: 05 July 2018).

Weaver, J.P., Chastain, R.J., DeCaro, D.A. and DeCaro, M.S. (2018) 'Reverse the routine: Problem solving before instruction improves conceptual knowledge in undergraduate physics.' *Contemporary Educational Psychology,* 52, 36-47. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0361476X17300991?via%3Dihub (Accessed: 22 June 2018).

Wielenga-Meijer, E.G.A., Taris, T.W., Wigboldus, D.H.J. and Kompier, M.A.J. (2011) 'Costs and Benefits of Autonomy When Learning a Task: An Experimental Approach.' *The Journal of Social Psychology,* 151(3), 292-313. Available at: https://www.tandfonline.com/doi/full/10.1080/00224545.2010.481688 (Accessed: 05 July 2018).