A case study into technical eLearning: Upskilling Excelitas' workforce with SPIE Partnership

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ABSTRACT

Electronic learning, or e-learning, is a vital educational format for the upskilling of the workforce, with promises to sustain accessibility to training in spite of travel restrictions brought by the Covid-19 pandemic. In addition, specialized online photonics courses are becoming increasingly available on the market, responding to needs of business employees to access on-demand technical teaching material to maintain competitive business advantages. It is in this context that Excelitas Technologies Inc. and the International Society for Optics and Photonics, SPIE, formed a partnership to deploy a platform to upskill scientists, engineers and project managers. Since June 2021, 60 employees across seven Excelitas sites worldwide have gained access to a library of technical courses offered by SPIE. The paper will present a case study into the instructional design, implementation strategies, and evaluation methods for this program. An evaluation framework based on the Kirkpatrick model is used to provide qualitative data to assess the quality of the learning delivery, the performance of the learners, and benefits to the organization. Preliminary evaluation results based on the analysis of pre-training and post-training surveys will be presented, along with lessons learned in organizational and learning development.

Keywords: eLearning, Learning and Development, Technical upskilling, Photonics Training, Continuous Education

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OUTLINE

Online learning is a fast-growing industry that offers potential to better the knowledge, skills, and productivity of industry professionals. Can technical electronic learning in photonics be of benefit to the existing workforce? In this paper, the authors present a case study for upskilling engineers and scientists through a partnership between SPIE and Excelitas Technologies Inc., acting here as training deliverer and recipients, respectively. The outline of the paper is as follows. §1 introduces the ecosystem for electronic-learning (eLearning) for technical training and outlines objectives for this case study. §2 provides an overview of the design of the program and features of the SPIE eLearning platform used to assist the implementation. §3 describes the program's evaluation framework and the assessment of the learning delivery and quality. Finally, §4 summarizes lessons learnt and future perspectives for the eLearning technical program.

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1. BACKGROUND

1.1 Electronic-learning for technical training

The use of high technology in STEM education is a well-documented process and a necessary evolution to augment the potential of traditional classroom teaching [1]. There is a strong potential for value-added to training across the photonics industry via in-company training as well as tools to allow career development [2]. There has been a rapid increase and diversification of online technical training, accelerated even more by the Covid-19 pandemic. This includes, but is not limited to, crowdsourced and custom-built tools [3-5], webinars for hands-on learning, [6], and open sourcing of lecture material [7]. Validating and recognizing this training within the framework of an organization is non-trivial. Accredited training provides a more established route towards this. This is typically available via generalist catalogues (Coursera, EdX, Udacity) which deliver some courses in electronics, electrical, and systems engineering with photonics applications. An increasing number of suppliers are filling the gap for photonics online learning to provide training to lower the barrier for entry to specialized areas, such as quantum photonics education [8] or photonics integrated circuits design and testing [9, 10, 11]. These package providers, however, do not yet address a number of sub-system level optical components, such as light sources, imaging, and detectors. There remains specialist photonics providers (SPIE, Optica, IEEE Photonics Society) with potential to act as suppliers for a vetted level of technical training, accessible worldwide, and with a solution able to integrate and scale across an organization.

1.2 SPIE-Excelitas program objectives

It is within this context that Excelitas Technologies Inc. (Excelitas) entered a partnership with SPIE, the International Society of Optics and Photonics, to access e-learning technical training for their staff. SPIE Education offers short courses taught by world-renowned experts teach courses from industry and academia. Interdisciplinary topics range from basic optomechanics to applications including defense, medical imaging, lithography, astronomy, optical fabrication, and augmented reality. This online portfolio came as a digital necessity in the absence of in-person training in 2021, due to travel constraints imposed by the Covid-19 pandemic. For Excelitas, a global network of design and manufacturing locations in the Americas, Europe and Asia, the SPIE e-learning offering aligned with the company's portfolio of innovative photonic technologies and products for custom photonic solutions and complex system integration to own-equipment manufacturers. The company's technical portfolio includes Lasers & Light Sources, Optics, Optronics & Imaging, and Sensors & Detectors, which are present across the SPIE Education catalogue. Table 1 outlines the technical educational offering of SPIE with Excelitas' program objectives, highlighting synergies between the two organizations to cater for a global group of Engineering and R&D professionals.

Table 1. (a) SPIE educational offering proposal (b) Excelitas program objectives

1. Refresh existing skills and knowledge	1. Technical development for Engineers and R&D
2. Stay current with evolving technologies	2. Assist managers changing roles or supporting new technology areas
3. Improve job performance by enhancing technical expertise	3. Increased employee engagement and support during Covid-19
4. Increase the value to the organization	4. Advances employee knowledge of emerging technologies for business application
5. Add value for personal growth and development through continuous learning	5. The development of a technical careers pathway and training solutions
(a)	(b)

2. PROGRAM DESIGN AND IMPLEMENTATION

2.1 Program design

SPIE worked as a technical e-learning solution provider to create a learning path via their learning management system (LMS, Accredible) for the delivery of online technical courses. The program was integrated with the Excelitas LMS (SAP SuccessFactors) following the workflow outlined in Figure 1. This includes pre- and post- training surveys

conducted via a cloud-based online survey tool (Microsoft Forms), and a set of custom tutorial sheets and videos to assist in the use of two digital LMS platforms. It was necessary to retain both digital platforms to (1) validate training taken through an external provider (SPIE) from in-company trainees (Excelitas), and (2) make use of the external e-learning platform features. The implementation for Excelitas staff required internal coordination with two (2) strategic business units, eight (8) Research & Development (R&D) and Operations function directors, as well as leads within the departments of Learning & Development (L&D) and Human Resources (HR). A program manager, this paper's lead author, was appointed for coordination and communication both internally and externally.

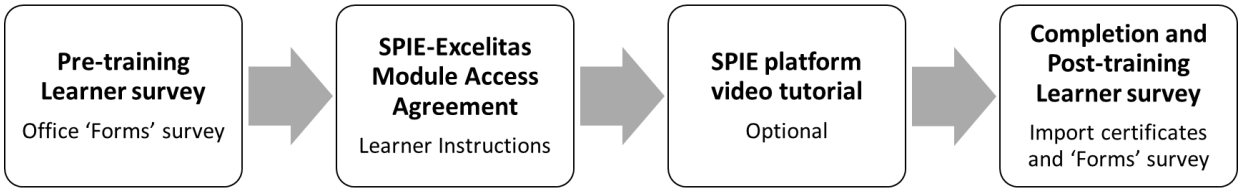


Figure 1. Workflow of the SPIE-Excelitas technical e-learning program.

Members of the Excelitas L&D department conducted a preliminary needs assessment regionally. The demand was found to be of approximately 350 course 'Seats'; we use the term 'Seat' to refer to allocations of individuals to a single-user, online course. Line managers then managed allocations across the technical functions of the organization; 58 of 60 allocations were in R&D engineering (R&D Eng.). The job roles were primarily engineering and development for mechanical and optical fields, and more specifically in areas of product design, test, assembly and applications. The geographic distribution was North America (20), Asia (2), and Europe (38). We note that twenty-four (24) employees were based in countries where English is not the primary work language.

Demographic data of the participants in the program was collected and compared to the overall R&D Engineer unit. The gender representation is representative of the population of the unit. We found an over-representation of staff with less than 1 year and at 5-10 years with the company, as illustrated in Figure 2. For the staff with less than one year of employment, the allocations are in line with the need to develop staff in their technical pathways at the early stages of their tenure with the organization. For the staff 5-10 years of employment, this may be due to moving to new functions, such as changing roles after a medium-term tenure and requiring new technical training. There is no straightforward methodology to verify this with the current employee database system, and it is left for further investigation.

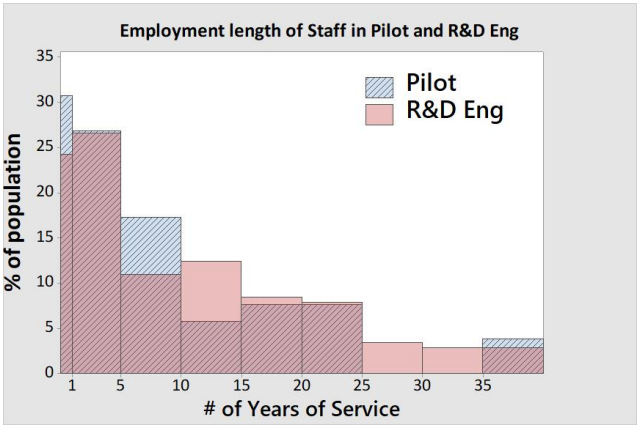


Figure 2. Demographics breakdown of the participants in the pilot (blue, N=58/60) compared to the overall staff population (red) of the Research & Development Engineering (R&D Eng.) function.

2.2 E-learning Platform overview

Training was delivered via an online learning platform. Figure 3 provides an overview of the interface used for the learning delivery. The principal education features include tutorials and frequently asked questions. Courses are divided into modules, typically 40-60 minutes each, with specific learning outcomes for topics. The overall training length is 4-8

hours and allows on-demand access to pre-recorded material, slideshow presentations, course notes (subject to instructor copyright), and quizzes. Access is provided to learners for one year from registration, with potential for use as a reference tool beyond the initial completion. The platform also contains modules with links to the instructor biography and contact details, providing a route to engage with the instructor outside of the learning platform. Recordings are accompanied with text transcripts and translation functionality is integrated with a browser-enabled extension (Google Translate). Learning dashboards display courses available and completed, including digital badges and certificates. The average cost of a single-user, online course is $400 USD, which includes a discounted rate for bulk seat purchases for this pilot program.

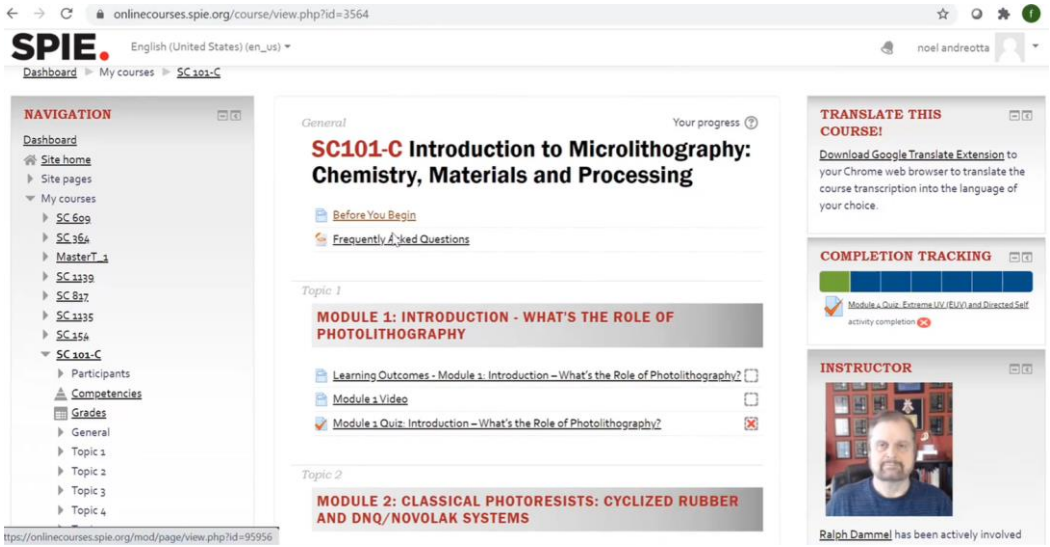


Figure 3. Overview of the dashboard for the SPIE e-learning platform.

3. EVALUATION

3.1 Evaluation framework

The Kirkpatrick model is a long-established methodology that provides a 4-level framework to assessing reactions, knowledge, behavioral change, and impact on the business objectives [12, 13]. This has been adopted to the business needs to map three areas of the implementation

1. Effectiveness: organization needs and organization benefits
2. Effect: required learner performance to achieved learner performance
3. Quality: learning design to learning delivery

Pre-training and post-training surveys accompanied the courses for the evaluation, and the implementation is summarized in Figure 4. Responses to open-ended questions were recorded and analyzed via thematic analysis. This analysis is susceptible to introduce interpretation bias [14], but also provide insights based on level of technical and pedagogic fluency of the analyst. The lead author of this study conducted the analysis, with results reviewed by co-authors. Natural language processing toolkits [15] could be used for the analysis to allow for a more systematic, robust and scalable evaluation, but is not considered as part of this study.

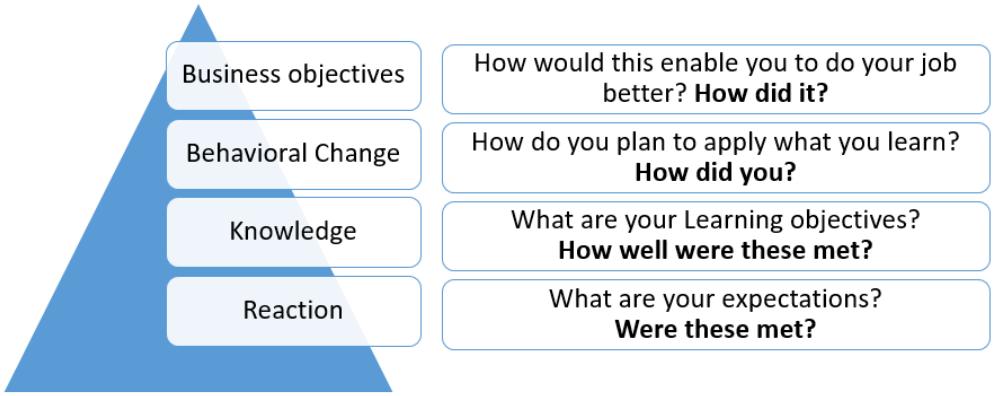


Figure 4. Implementation of Kirkpatrick's four level of evaluation for survey design in the eLearning program.

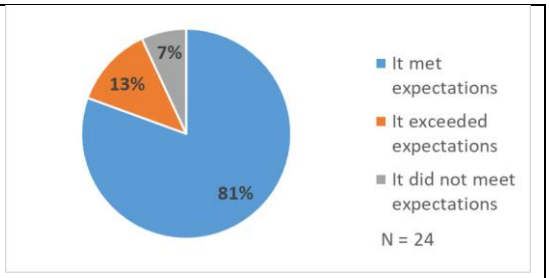
The program was launched in June 2021 and at the time of writing in July 2022, 48 people have started the course and 24 have completed. Non-starters are primarily from countries where English is not the primary language of work and communication. A completion rate of 75% (45/60) is expected by June 2023, based on current course registration. No time constraints were imposed for Excelitas employees to access and complete the course; the priorization was left to individual line managers, although some strategies to incentivize this were implemented and will be discussed in §4.

3.2 Value of technical training

The reaction and assimilation of knowledge were evaluated using responses from the post-training survey, with evidence found that trainees developed knowledge and transferable skills. Figure 5 (a) highlights three such skills developed. The survey responses provide evidence that the SPIE courses led to the development of transferable skills for technical applications (8), comprehension (4), knowledge (3), analysis (1), and problem solving (1); 7 of 24 responses lacked quality for a thematic classification. From the current post-training survey, no records of synthesis and evaluation were identified; this may be linked to the methods of interpretation in the analysis phase. The participants' learning objectives were largely met or exceeded expectations as highlighted in Figure 5 (b). Staff technical development objectives stated in the pre-training is aligned to the technical pertinence of the SPIE courses available.

Analysis	"*Course [SC212] has improved my problem solving at work by enabling me a new technique to investigate optical surfaces*"
Evaluation	"*Training [SC1019] help me better understand the variables involved and make better choices*"
Knowledge	"*The repetition of exposure was good to confirm knowledge*"

(a)



(b)

Figure 5. (a) Testimonials from employees on knowledge and transferable gained during the course (b) Summary of the response to the post-training survey question "How did the learning outcomes meet your expectations?"

The analysis of the pre- and post-training survey responses provides evidence of behavioral change and impact on the business objectives. Figure 6 (a) introduces the concept of "Learning Quality", which is defined on a 4-level based on the thematic analysis of the survey responses:

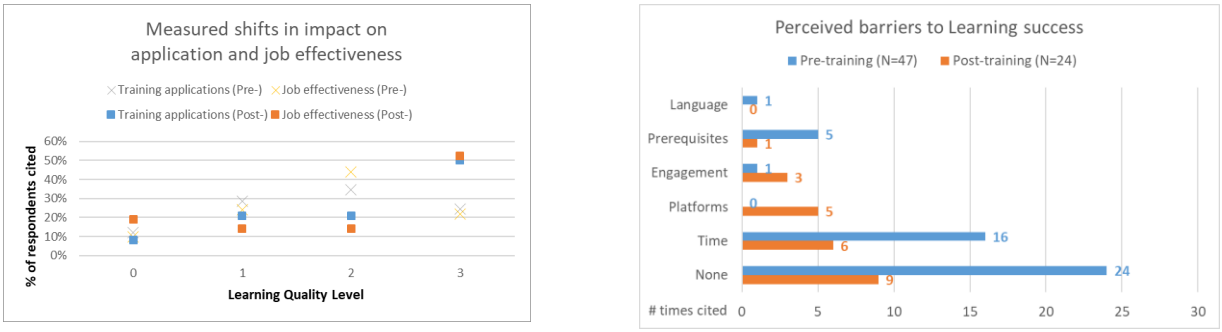
0. Not specified
1. General knowledge
2. Technical knowledge
3. Work applications

Learning quality of levels 2 and 3 is where the respondents have provided deep and meaningful insight at the planning stage of their learning, and demonstrated this during the evaluation, for instance by showing change of behavior or aptitude. Furthermore, the analysis of survey responses allows quantification of the size of the population that anticipates or has achieved personal or technical development. For these types of responses (levels 2-3), the technical nature of the development can also be qualified. The responses reveal that design, assembly and testing skills of optical components and systems are the principal applications of learning and improvement in job performance.

"The course [SC015] will help me to understand several techniques so that the amount of time that I need to use for research will be reduced." (Pre-training testimonial)

"I suggested a new bonding technique presented by the course [SC015] to my colleagues." (Post-training testimonial)

Qualitative feedback has provided insights into the effect of the training for improving speed, creativity and knowledge sharing of Staff. Trends observed manifest an increase of the population having identified an application in their technical roles of the material presented as well as a decrease of the population that have only identified technical knowledge. With reference to Figure 6 (a), Learning Quality levels 2 and 3 are identified in 31 of 52 (59%) pre-training survey responses and in 16/24 (67%) of post-training surveys. We note no significant shifts in the populations of people who had not identified learning outcomes (0) or just general knowledge (1); more data is required to fully assess these and map the impact of the training on the overall population, in particular shifts in the quality of learning of populations. Case studies to explore this in-depth will be of value to further highlight benefits and incentivize completion of the courses.



(a) (b)

Figure 6. (a) Impact of training on job effectiveness and ability to apply the training. (b) Perceived barriers to learning success. Pre-training respondents N = 47. Post-training respondents N = 24.

A majority (24/47) of participants did not anticipates issues to completing their courses, and a significant number (9/24) did not find issues after completing the course; we conceptualize these as "barriers" to "learning success" for the purpose of this discussion, and these are summarized in Figure 6 (b). Prior to the start of the training, 23 participants (~50%) identified concerns for time management strategies and lack of awareness of available resources with the course; 15 finishers (~60%) reported on barriers found in completing the course. A number of actions were set up as a result to provide incentives for prioritization and time management strategies; these will be reported in §4 as the evaluation of the impact of these of these is ongoing. After training, a new barrier was discovered, namely platform issues. These include browser issues, LMS access, as well as interfacing between the LMS of Excelitas and SPIE. The findings justify the need for having support resources for users at both customer (Excelitas) and provider (SPIE) via 'traditional' communication means (email, phone) during a pilot phase; scaling may require a different implementation for support.

The use of the language features should be considered for accessibility. While it was not possible to track the use of the transcript translation feature, the pre- and post-training surveys had the option to enable a different language, which was used by 10-20% of respondents. There is a correlation with the slower start and finish rates for participants in non-English speaking countries. Further efforts would be required to interview non-finishers to gain insight into limitations of this program that may hinder future scalability.

4. LESSONS LEARNT AND PERSPECTIVES

4.1 Organizational benefits of SPIE-Excelitas partnership

The case study described the design, implementation and evaluation of a program to upskill Excelitas' workforce through a partnership with SPIE. The initial needs assessment led to a program launch of 60 technical courses, and an over-demand for technical training resulting. The high-demand permitted a significant (25%) discount to the price of courses, as well as further site-driven enquiries access for technical e-learning courses based on local development needs.

At the time of writing, the start rate is ~5/6 and the completion rate ~1/3; the estimated time for 2/3 completion rate is July 2023. The current completion rate limits the direct mapping of the benefits of the programs for individual learners. Evidence in testimonials reveals that the courses have the potential to be used as a tool to supplement on-the-job training, which is a significant return on investment for an electronic training solution. Communication and methods for integration into Excelitas' internal LMS have been designed to encourage staff and line managers to prioritize, pursue and record these development opportunities; evaluation is currently ongoing.

The program provides evidence of the importance for organizations to act collaboratively to implement focused technical learning programs supported by robust evaluation tools. The evaluation framework highlights the value of conducting analysis accounting for technical training, with routes to show impact to the performance of the business, ability members of technical staff and career growth for professionals in the field. Learning acts an aid to accelerate technologic innovation and organizational agility, and the work should be pursued in line with the development of best practices within the photonics education and training, such as implementing new spaces [16], technologies [17] and scaling of programs [18]. Professional trends in the larger L&D field may be monitored by engagement with professional societies, such as the Association for Talent Development (ATD) or L&D analysts (RedThread Research).

4.2 Further engagement strategies

A significant demand to connect with peers was identified, and a corporate communication channel (Microsoft Teams) was set up to cater for this. Its' membership is comprised of 50% of people in the pilot program, highlighting the need for access to learning beyond staff selected. The platform requires regular activity and curation of content to build a technical learning community, and to date, content includes news on webinars, sample courses, tips for eLearning, access to support contact and resources.

Initial access to SPIE courses was high and subsequent internal communication from HR and L&D teams have been efficient in sustaining start and completion. External communications have a less tangible impact on the program metrics, but are consequential nonetheless. The SPIE-Excelitas program launch generated over 15k impressions via social media and newsletters; a guest webinar delivered by SPIE to the Excelitas global technical community was attended by 40 members of staff, including representatives from senior management. Further in-depth analysis of learner profiles are being investigated to create case studies to highlight the benefits of online training, and feed into further adoption within the organization and the ecosystem at large. .

A more holistic approach is underway to integrate the offering of the SPIE Education webinar programs with the Excelitas continuous learning initiatives. This includes the broadcast and internal cataloguing of bi-monthly webinars provided by instructors for an overview of course topic. SPIE also created a demonstration course specifically for Excelitas employees to familiarize themselves with the learning platform. The integration with the LMS is intended to build usage and fidelity, as well as recording and valuing participation in vetted technical training courses offered outside of the organization. Figure 7 summarizes strategies for engagement based on the organizational benefits and evaluation of the engagement strategies used.

Tools and resources	Informal Learning	LMS integration	Business objectives	
• Tips for eLearning	• Peer learning groups	• Automated notifications	• Staff needs' development	Push
• SPIE trainer support	• Online forum and webinars	• Map training presence	• Continuous performance	Pull

Figure 7. Summary of engagement strategies for SPIE-Excelitas eLearning program

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