



An Evaluation of how Agile and Scrum Approaches for Running Teams can Improve Teaching and Research in Work-based Higher Learning

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ABSTRACT

Academic activities can be streamlined and structured as teams using scrum approaches. Outside of academia, researchers have reported the benefits of such a collaborative and team-focused approach, particularly in industry. This study investigates how to structure academic activities as teams and then apply scrum practices to run the teams to improve teaching and research in work-based higher learning. The study adopts an action research methodology. Data from interviews and surveys were collected and analyzed using thematic analysis and descriptive statistics. The findings revealed that agile and scrum practices should be formalized to improve teaching and research in work-based higher learning.

Keywords

Academic activities, Teaching, Research, Teams, Agile, Scrum, work-based learning

1. INTRODUCTION

One of the challenges of the Graduate Apprenticeship (GA) programs for students and lecturers is managing and streamlining academic activities to cope with the increasing workload. The Graduate Apprenticeship program is different from the traditional graduate program because it is a work-based learning program where students gain a degree while working in paid employment. Attendance is mostly at work, with different options for university attendance - from day release to block release or online learning, or a combination (Skills Development Scotland, 2021). Lecturers and students in the GA programs are expected to embrace online learning modes and conduct academic activities (e.g., research, teaching, assessment). The unanticipated shift of online pedagogical activities (for example, due to COVID) has contributed to additional stress and obligations for university academics and employees. (Houston et al., 2006; Houliden & Veletsianos, 2020).

The Guardian reported that more than half (57.5%) of the staff surveyed in a recent study said they were struggling with an increased workload and poor mental health because of the COVID pandemic, while more than a fifth (23.3%) were working a bit harder (Guardian, 2021). According to the Student COVID Insights Survey (SCIS) conducted by the Office for National Statistics (ONS), it was reported that over half (61%) of students who were in higher education prior to the outbreak of the coronavirus (COVID-19) pandemic reported that the lack of face-to-face learning had a major or moderate impact on the quality of their course; around a half (52%) said that the pandemic had a major or significant impact on their academic performance (Office for National Statistics (ONS, 2021).

Research and teaching activities can be run as a team to

streamline academic processes, and researchers have reported the benefits that such a collaborative and team-focused approach offers outside academics, particularly in the technology industry using Agile and Scrum practices (e.g., engineering, IT/Software, medicine, etc.) (Vogelzang et al., 2019; Fernandes et al., 2021; Barker, 2018). Agile approaches have been successfully applied to teaching in traditional university degree programs (V4). The findings of a recent case study conducted by the Agile Business Consortium at Northumbria University's London campus revealed that the use of Agile methodology in teaching practice aided in adapting teaching to different cultures, student backgrounds, and learning styles (K2) (Agile Business Consortium, 2020).

Although, agile approaches have been applied to academic activities (e.g., research and teaching) in traditional graduate programs (V4, K2), little research has been conducted to examine the impact of using agile approaches (e.g., Agile Teaching Framework, scrum framework) on research and teaching at Graduate Apprenticeship programs. In addition, these activities have not been structured into teams to explore how these activities can be streamlined to benefit both students and lecturers in the GA Program. A framework to teach and support the implementation of Agile practices has been prepared in the study (see Appendix G). This satisfies K2, A2 aspect of the PSF.

The paper is structured as follows: Section 2 presents the study's research questions, aim, and objectives. Section three reviews the literature on agile methodology and its application to academic activities such as research and teaching. The research methodology is covered in section four. The findings and discussion are presented in section five. The study concludes with recommendations and future work in section six.

2. AIM AND OBJECTIVES OF THE RESEARCH STUDY

The study aims to investigate how academic activities can be structured as teams and then apply agile approaches to run these teams to improve teaching and research in a work-based higher learning environments (e.g., Graduate Apprenticeships programs in most universities in the UK). The specific objectives of the study are to:

- (i) Critically review the literature on applying the agile approaches to improve academic activities, especially teaching and research (see Sections 1 and 3).
- (ii) Provide a novel implementation framework for Scrum practices in context-based teaching and research in a work-based higher learning environment (see Appendix C).
- (iii) Evaluate the framework's applicability in an action



research study involving students and lectures in a work-based higher learning environments (see Sections 4 and 5).

(iv) Provide recommendations and best practice guidelines on applying the approach to improve teaching and research in a work-based higher learning environments (see section 6.2).

3. LITERATURE REVIEW

Academics have long struggled with streamlining their process to improve academic research and teaching. One of the approaches to streamlining academic activities is to create teams for performing academic activities and then apply agile methodologies to run these teams. Running projects as teams have been going on in the technological industries for many years, but recently it is increasingly being applied in academics to improve research and teaching (Baker, 2018).

Agile methodologies have been widely used in the industry, particularly in technology (e.g., engineering, IT/software). Agile methodologies are iterative development methodologies that emphasise lowering process overheads and documentation while delivering incremental software (Sommerville, 2015). They directly involve client representatives in the development process. Several agile approaches can be used to run teams – Scrum, Kanban, Lean, Extreme Programming (XP), Crystal, Dynamic Systems Development Method (DSDM), and feature-driven development.

Like any other professional project development method, Agile development has to be managed to make the most use of the team's time and resources. Scrum is an agile technique that was created to address this problem by providing a framework for structuring agile projects and, to some extent, allowing external visibility of what is happening (Schwaber and Beedle 2001; Rubin 2013). It is organised around a series of sprints, which are specific time intervals during which a system increment is produced (Sommerville, 2015).

Scrum provides ceremonies, roles, and artefacts for tracking progress, adapting to changing conditions, and reflecting on the quality of intermediate products (Schwaber and Sutherland, 2017; Atlassian, 2022). Scrum technique may be a remedy for streamlining and collaborating challenges commonly experienced by students in an educational context (Pope-Ruark, 2012; Pop-Ruark, 2015; Rodriguez, Soria and Campo, 2013) (V3).

A typical Scrum project in an educational setting begins with a teacher (i.e., likened to a product owner in a scrum project), formally presenting a somewhat complex, real-world question to his students. The teacher specifies the learning objectives, ties the real-world question to his students' personal life, and offers students artefacts such as a scrum board and a product backlog, including a list of exercises and assignments required to answer the real-world question (Vogelzang et al., 2019; Vogelzang et al. 2020; Vogelzang et al., 2021). This study has prepared a framework for applying scrum practices in teaching in the GA program and shows the use of evidence-informed approaches from research and teaching (V3).

4. RESEARCH METHODOLOGY

The research methodology adopted for this study is action research methodology. Action research promotes collaboration between researchers and organisation members to solve organisational problems. It involves action, evaluation, and critical reflection and – based on the evidence gathered – changes in practice are then implemented (Bryman and Bell, 2011; Koshy, 2009).

The study uses a combination of interviews (see Appendix C for sample questions) and online questionnaire (see Appendix B) to elicit responses from participating lecturers and students in the GA program, School of Science and Engineering. The study provided a sample implementation of the scrum practices in the GA program, which explains how corresponding scrum artefacts in teaching and research (e.g., module specifications, list of topics) are provided to students before the start of the module as recommended when practising scrum in the industry (K1). The study used the UOD's official survey service, and the data was stored in accordance with the university rules.

The action research study has evidenced critical and reflective engagement with professional practices and demonstrated successful engagement in CPD activity related to professional practice responsibilities (V3). For example, I have developed and implemented agile and scrum practices in context-based teaching of IT Software Development in the GA program of the University of Dundee. Also, I collected and analysed data from interviews and questionnaires to gain insight into lectures and students' experiences during the implementation of agile and scrum practices and what it would look like in future if these practices were formalised. In addition, I was able to discuss the lesson materials and assignments with students and what would be the most effective ways of developing and sharing the materials to improve their learning experience (A2, K2, K3).

5. FINDINGS AND DISCUSSION

The research findings and discussion will be divided into interviews and surveys.

5.1 Findings and Discussion from the interview

Scrum is a framework that helps teams work together (Heroux, 2019). The following section discusses how academic activities can be structured as teams and how scrum roles, artefacts and ceremonies can be applied to those teams to improve teaching and research.

5.1.1 Application of scrum roles and responsibilities in teaching and research

The lecturers agreed that some scrum roles and responsibilities are adaptable to teaching and research. For example, the lecturers can act as product owners because they are assigned to teach courses. The class reps serve as scrum masters, and the development team can be made up of the entire class. One of the challenges is how the class rep can liaise effectively with the class members and provide balanced feedback to the lecturer. One of the lecturers captured this challenge: "The only downside is that he shouts loudest, gets what he wants" [Interviewee 7]. There may be students in the class that may not be in favour of certain decisions but do not want to complain. These students may feel that they are not being listened to and may decide to go with the majority. As a result, the interviewee advised that the lecturer (likened to the product owner in scrum) cannot satisfy every class member and should therefore be very firm in making decisions to avoid losing control of the class (i.e., the team).

5.1.2 Application of corresponding scrum artefacts in teaching and research

Scrum artefacts (e.g., product backlog, sprint backlog, and increment) can be implemented in teaching and learning and regularly reviewed during the semester/term. Most lecturers agree that product backlog corresponds to Module specification and Sprint backlog corresponds to topic/lesson outline and



objectives. The increment corresponds to class activities, quizzes, or whatever is implemented to assess the student's understanding of the topic/lesson. The challenge is that if the deliverables are too frequent, the students would be overwhelmed and start complaining and ultimately lose interest in the module. One of the lecturers admits that applying scrum artefacts would relieve and spread the workload for students but says, "The unfortunate thing is that they see this and say, Oh! It's relentless. You want me to do something every week?" [Interviewee 7]. The lecturer further advised that whichever lecturer implements this would have to put a bit of thought into it [Interviewee 7]. The appropriate use of subject material and methods for teaching and assessing students using scrum artefacts (e.g., module specification and topics objectives) satisfies the K2 of the PSF.

5.1.3 Application of scrum ceremonies in teaching and research

The interview revealed several types of scrum ceremonies that can be adapted to teaching. The 'grooming' is the first, where the lecturer (the product owners) updates and organises the list of topics for the module/course to be delivered to students. Another ceremony is the daily stand-up meeting, where the lecturer discusses with the class to voice any concerns they have with meeting the objectives of the lessons and the module. The sprint review is another meeting that has been found to be very useful where the lecturer reviews the lesson objectives with the students after the lesson. Also, the lecturers might want to review the assignment questions to demonstrate how the lessons delivered fit into the assignment questions. One of the lecturers stated that this type of review, "in an engineering context, might be drawings" [Interviewee 2]. Students have found this very useful, and lecturers have confirmed that this has helped clarify difficult concepts in the course and ensure that students are well supported.

5.1.4 Facilitating and Inhibiting factors in the implementation of Scrum practices in teaching and research

One of the concerns raised by the lectures is that if students knew that their teaching methodology might be based on Scrum practices, some students might be worried about its negative impact on them.

The lectures shared their opinions on several factors that hinder the implementation of scrum practices. One of them is that students may not be comfortable with Agile and Scrum because of the concern that this might shine the spotlight and thereby affect their overall performance

One of the lectures said: "we have had problems with certain people wanting to take the lead and others definitely not wanting to take the lead in Group projects." [Interviewee 2]

Another factor that could hinder the implementation of agile and scrum practices is the fact that academics can sometimes be resistant to change. As he put it "people are already desperate to go back to the old-fashioned lecture tutorial format. You know, as soon as the soon as I alright we've done the online thing. So, I think you know people wanting to regress back to old ways." [Interviewee 10]

Some of the factors that could facilitate the implementation of agile and scrum practices are making sure that we review the program to meet the GA framework and then domestic design reviews. As he rightly put it, "so we need to look back at the requirements which is in the graduate apprenticeship frameworks". [Interviewee 10].

5.1.5 Impact of scrum practices on teaching and learning style

The majority of lecturers agreed that implementing agile and scrum practices in the GA program will not negatively impact teaching and learning. However, if it is not properly implemented, it may negatively impact. For example, one lecturer said: "it would have a negative effect if we were not following the procedure and if we were not properly reviewing and always checking our requirements" [Interviewee 10].

Another lecturer said that he could not think of any negative impact that implementing agile and scrum practices would have on the teaching and research in the GA program. The lecturer said that Agile allows you to make modifications and then continue instead of waiting until the end of the lectures. The lecturer said, "you can actually adapt to different situations and circumstances, unlike if they say this is the only way you do things" [Interviewee 5].

One of the lecturers expressed concern that agile and scrum practices promote change which can sometimes come very quickly. If changes were to happen, then students may complain. If the lecturers are not able to keep up with the change, then they may resist the changes or lose confidence in each other ability to deliver on the requirements of the GA program. [Interviewee 5]

5.1.6 Motivation to use scrum practice in future for teaching and learning

Most lectures have established that they would like to use scrum practices in the future, and they cited flexibility and adaptability as the reason they would want to use scrum in teaching and research. This finding agrees with other researchers that have established that agile and scrum practices can increase students' motivation and positive attitude toward chemistry while achieving learning outcomes that are comparable to or better than traditional approaches (Eilks and Hofstein, 2015)

Another motivation that has been discussed is the ability to get things done very quickly. As one lecturer rightly stated, "new designs and changes to modules can be delivered". However, the lecturer advised that there should be a careful thought on the types of changes to make to the teaching and research - these could be making changes to the module, preparing new content, having module content reviewed by other peers or second marking [Interview 4].

5.2 Findings and Discussion from the survey

The survey questions were structured around key scrum concepts such as scrum practices, ceremonies, roles and responsibilities, and artefacts. (see Appendix A for the online survey results).

This study described how scrum practices had been used in teaching IT Software Development in the GA program of the University of Dundee. The information forms part of the documentation provided to students to understand agile concepts before filling out the online survey. This satisfies the A1, a key aspect of the PSF required for this assessment.

To satisfy V3 of the PSF, I introduced several evidence-informed approaches and outcomes from the action research study. The evidence-informed practice involves combining various forms of general knowledge with local knowledge (e.g. professional expertise) in response to specific practice challenges in the local context (Markauskaite and Goodyear,



2017; Staempfli, 2022). Specifically, I postulated well-developed answerable research questions (e.g., understanding and application of agile and scrum practices in teaching) to demonstrate how to integrate the critical evaluation with lecturers' and student experience in the GA program. I also evaluated the effectiveness of implementing scrum practices in the future.

5.2.1 Ceremonies

The survey results show nearly 60 per cent of the respondents either Agreed or Completely Agreed to the question that asked whether they would like their assessment to be split into smaller units. This is one of the key features of scrum projects, where projects (large and complex projects) can be divided into smaller projects so that they would be easy to manage. In teaching, this would translate to splitting assessment into different components, such as asking a student to submit coursework in a report format where the coursework has various components (or questions), such as theoretical or written questions, programming, and diagramming. This approach of dividing an assessment into smaller and different units satisfies K3 aspect of the PSF. Students recommended various tools to facilitate scrum ceremonies to improve teaching and research. These include collaboration tools such as Microsoft Teams (chat, audio, and video), Email, Blackboard Collaborate, My Dundee, and monitoring and tracking tools such as Trello. This evidences the use and value of appropriate learning technologies (K4).

5.2.2 Roles and responsibilities

Nearly 70 per cent of respondents said that they would not allow group assessments to be introduced to complement the existing assessment structure in the GA program. It is understandable why respondents may not be comfortable with the Group assessments as the GA program is a work-based learning program. One or two students' poor performance may impact the whole class's overall score.

The respondents overwhelmingly (nearly 95%) agreed that they would prefer lecturers to be provided with the opportunity to review and provide feedback on draft assignments before final submission. This approach is like presenting a demo of the project deliverable to stakeholders for review and feedback to gain insight into how to improve project outcomes (K5). At the end of the term, I observed that students who submitted a draft of the assignment for feedback performed better than students who did not do the same. This evidences the feedback given to learners (A3), and the use of appropriate methods for teaching (K2).

5.2.3 Artefacts

The survey asked respondents which scrum artefacts would be useful in making resources transparent to all students to improve teaching and research in the GA program? Over 50 per cent of the respondents chose Product Backlog compared to 33.3 % and 16.7 % for Increment (or Demo). The list of items in the product backlog can be compared to the module specification, course outline and list of lesson topics. This means that one of the most important lists of resources that students need are those that can be likened to the list of items in the product backlog. Lecturers usually overlook this type of information but rather concentrate on the lesson content and objectives or a list of activities for each lesson.

5.2.4 Tracking and Monitoring

Over 80% of the respondents chose Microsoft Teams (chat, audio, and video) as the most useful Agile and Scrum tools for

collaboration and communication. The other tools include Email, Blackboard Collaborate, and My Dundee. The other tools are good, but they are not frequently used as Microsoft Teams, as the survey shows.

An interesting finding from the survey is that 50% of the respondents chose Trello, a tool for tracking and tracking the work of team members in the industry, as a key tool that can be used to track and monitor students' progress. These other tools are Slack and JIRA, which can also track and monitor students' progress. The important point to take from this finding is that there is a need for tools and processes to track and monitor the progress of students in the module or course they offer in the class.

Respondents were also asked an open-ended question about how lecturers and school administrators could monitor and track students' learning progress in the GA program using scrum methods (e.g., scrum boards, burndown charts). Some of the responses include using scrum methods to keep class activities/assignments on track. One respondent expressed concern about whether scrum practises would be an effective method for monitoring and tracking students' learning progress because each student is an individual, and their progress would be treated as a separate project. One of the respondents recommended burndown (or a similar tool) to show how much each student is performing and see if it is consistent with what was expected. This will also show if one student is working harder than the other. Another respondent advised that students should be marked individually based on their input.

5.2.5 Reflection on the use of scrum practices

The respondents were also asked about the factors that might hinder or facilitate the implementation of scrum practises in teaching and research. One respondent stated that the understanding of lecturers and students is an important factor that could facilitate the implementation of scrum practices because scrum is a complex framework for implementing agile and scrum practices.

Another factor will that has been mentioned is students' attendance and the availability of time for students outside of the university hours that students must work. Student attendance is an important factor for two main reasons. Some of the classes are so small that if students are divided into smaller groups, then the performance could be impacted negatively if one of the class members is absent (e.g., due to illness). The second reason is that the GA program is a work-based learning program and students only have one full day in a week for full-time students compared to regular students who study full-time and have more time for activities. This means that students in the GA program could struggle with the different artefacts that are expected to be delivered and take part in the several ceremonies and meetings that may be required to monitor and track the performance of students in the class or sub-groups. As one respondent has said, "The only thing I see being an issue is people's schedules on days that are not a university, as we all have full-time jobs that we are committed to."

Another respondent advised that because scrum emphasises team-based activities and collaboration, its implementation would require more group-based activities and assessments. Given the course dynamics, it can be difficult to coordinate such activities. Previous experience has shown that the workload has been disproportional, with some students contributing far more than others but being marked as a group. As one respondent said, "If some students don't perform their



work to a high standard, it can reflect badly on everybody and make the whole project more difficult. This is the main difficulty for group projects.”

The students were also asked to express their opinion on what would motivate them to accept the use of Scrum practices. Again, the respondents said they would need evidence on two aspects: (i) the first is evidence that shows how effective the application of agile and scrum practices have been in other similar environments. (ii) the second is evidence of increased knowledge and understanding by lecturers and students of agile and scrum practices.

One of the motivating reasons given by respondents relates to the ability for students to choose their groups, assurances that the poor performance of the other groups would not affect their own performance, and the ability of students to work from home or remotely also contribute individually to group activities. This is because most students in the GA program are already used to working independently from home. One of the respondents said: “I personally prefer working at home, so that is a motivation. It is also a practice that I use every day in my work life, so it would be very normal to have a stand up in the mornings, weekly retrospective etc.”

6. CONCLUSION AND RECOMMENDATIONS

6.1 Recommendations

This study recommends the following based on the finding of the study.

6.1.1 Demographics of students

The university policy should be structured to attract students with a more diverse background and demographics to the GA program. The study revealed that even though the GA program is a worked based learning program, the demographics are slightly tilted in one direction. For example, the majority of students in the GA program are males, especially in the science and IT); the age range is primarily young adults, and they still feel that agile and scrum practices are for the industry, not about academics. It is only normal to expect that a mixed demographics that includes all age categories and increased awareness of information technology will help students be more receptive to implementing agile and scrum practices in teaching and research.

6.1.2 Awareness of Agile and scrum practices

The findings of the study have highlighted the importance of creating awareness about the usefulness of applying agile and scrum practices in teaching research in the GA program. This awareness could be in the form of a workshop or instructional material provided to lecturers before the start of a new session. This awareness will help both students and lecturers to begin thinking of academic activities as a project, just like the normal project in the industry. Once this awareness has been created, it will be possible to structure academic activities as teams and then apply scrum practices to these teams to improve teaching and research. Students will be receptive when they understand the value of scrum practices and the value that they will bring to their learning.

6.1.3 Formalising Agile and Scrum Practices

One of the key findings of this study is that some lectures have used some agile and scrum practices without even realising what they have done. This implication is that they have not used it properly, and even if it is so, there is no framework to monitor and track the progress of the practices and the impact it has on

students’ learning process. As a result, scrum artefacts such as sharing module specifications, a list of topics, and lesson objectives (which can be likened to product and sprint backlog) should be shared and reviewed with students regularly throughout the course. There should also be a framework to check that students have read, understood and are satisfied with the plan to achieve this module specification. Agile and scrum practices could be formalized by integrating them into the GA framework and the module specification for each course. For example, the Module specification could state that lecturers are expected to carry out certain scrum ceremonies (e.g., module review and retrospectives) at specific periods in the term. Agile and scrum practices have been incorporated into the curriculum of several higher education schools to handle students’ group projects (Opt and Sims, 2015).

6.1.4 Monitoring and Tracking Scrum Practices

The study revealed that the lectures and students would benefit from monitoring and tracking academic activities. The students would be able to monitor their learning progress. There are various tools for monitoring scrum projects in the industry, such as scrum boards that promote the visibilities of the project’s tasks to all stakeholders and some specialised software like Trello. One of the tools that could benefit the GA program is a tool that shows the different hand-in dates and submission dates for assignments. This tool could be integrated with existing tools such as Blackboard Learn (i.e., MyDundee in the University of Dundee) to track the number of students who have submitted their assignments at the deadline and those who may not be able to meet the deadline. Lecturers would be able to monitor their teaching and research activities, for example, the assignments questions and submission deadlines. The suitability of the Trello to support a scrum process and a Kanban board for the professional development of in-service school teachers has already been investigated (Parsons, et al., 2018).

6.1.5 Structuring Academic activities as teams

As much as possible, it would be recommended that academic activities such as teaching and research should be structured as teams and sub-teams. This would be beneficial for two reasons: managing teams and sub-teams might be a lot easier, and applying agile and scrum practices to those teams would also be easier. This can be implemented by dividing the whole class into smaller groups and providing a group assignment or activity. After that, scrum practices such as roles (e.g., class reps) and ceremonies(e.g., review and retrospectives) could be applied to run these teams. Again, the assessment can be broken down into smaller parts. For example, essays, diagramming, and programming could be included in an IT Software Development course. The sum of all the different parts of the assessments would be used to calculate the final grade for this course. Structuring academic activities as a team has been implemented by academics to improve research (Baker, 2018).

6.2 Conclusion and Future Work

This study discussed how to investigate how Agile and Scrum practices can be structured as teams and then apply agile and scrum practices to run the teams to improve teaching and research in the GA program. The action research collection data through a combination of online surveys from students and interviews from lectures in the GA program.

The study revealed that most lecturers are familiar with the term Agile but have never heard of the term or are familiar with scrum. As a result, they are where unable to understand that agile is methodology and scrum is a framework for



implementing Agile practice. The study revealed that most scrum practices had been applied in one way or another, but there is no formalised way of evaluating these practices. Some of the practices include scrum roles (e.g., the product owner as of the lectures, scrum masters as the class rep), scrum artefacts (e.g., module specification, list of all topics), and scrum ceremonies (e.g., daily stand up, review meetings).

This study concludes that agile and scrum practices can be incorporated into certain academic activities to improve teaching and research in the GA program. However, it would be recommended that lectures and students be trained on the basics of agile and scrums and then particular scrum practices that need to be applied. One of the scrums practices required is group activities, and the breaking up of students' activities into different components and then all the marks added to give the final grade in the assessment.

In the future, we proposed conducting a more detailed quantitative study that use inferential statistics to discover how key factors revealed in the study impact teaching and research in the GA program. Examples of these activities include introducing group activities and ceremonies into teaching and learning in the GA program.

7. REFERENCES

- [1] Agile Business Consortium, 2020. Case study: Northumbria University embraces agility at its London Campus by nurturing agile Lecturers. [Online] Available at: <https://cdn.ymaws.com/www.agilebusiness.org/resource/resmgr/documents/casestudy/northumbria-uni-case-study-2.pdf> [Accessed 28 November 2021].
- [2] Atlassian, "What Is Scrum?" (Atlassian 2022) <<https://www.atlassian.com/agile/scrum>> accessed 15 May 2022
- [3] Barker, A., 2018. An academic's observations from a sabbatical at Google. *Communications of the ACM*, 61(9), pp.31-33.
- [4] Bryman, A. and Bell, E., 2021. *Business Research Methods*. 3rd ed. New York: Oxford University Press.
- [5] Fernandes, S., Dinis-Carvalho, J. and Ferreira-Oliveira, A.T., 2021. Improving the performance of student teams in project-based learning with scrum. *Education Sciences*, 11(8), p.444.
- [6] Guardian, 2021. Four in five university and college staff struggling because of pandemic, union says. [online] London: Guardian. Available at: <<https://www.theguardian.com/education/2021/mar/04/four-in-five-university-and-college-staff-struggling-because-of-pandemic-union-says>> [Accessed 28 November 2021].
- [7] Heroux, M.A., 2019. SOFTWARE ENGINEERING BEST PRACTICES: Why What and How (No. SAND2019-10204C). Sandia National Lab. (SNL-NM), Albuquerque, NM (United States).
- [8] Houlden, S. & Veletsianos, G., 2020. Coronavirus pushes universities to switch online classes - but are they ready?. [Online] Available at: <https://theconversation.com/coronavirus-pushes-universities-to-switch-to-online-classes-but-are-they-ready-132728> [Accessed 28 November 2021].
- [9] Houston, D., Meyer, L. H. & Paewai, S., 2006. Academic Staff Workloads and Job Satisfaction: Expectations and values in academe. [Online] Available at: <https://www.tandfonline.com/doi/abs/10.1080/13600800500283734> [Accessed 28 November 2021]
- [10] Koshy, V., 2009. *Action research for improving educational practice: A step-by-step guide*. Sage.
- [11] Markauskaite L and Goodyear P (2017) *Epistemic Fluency and Professional Education: Innovation, Knowledgeable Action and Actionable Knowledge*. Dordrecht: Springer
- [12] Office for National Statistics (ONS), 2021. Coronavirus and first year higher education students, England: 4 October to 11 October 2021. [online] Office for National Statistics (ONS). Available at: <<https://www.ons.gov.uk>> [Accessed 28 November 2021].
- [13] Opt, S. and Sims, C.D.L., 2015. Scrum: Enhancing student team organisation and collaboration. *Communication Teacher*, 29(1), pp.55-62.
- [14] Parsons, D., Thorn, R., Inkila, M. and MacCallum, K., 2018, December. Using Trello to support agile and lean learning with Scrum and Kanban in teacher professional development. In 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE) (pp. 720-724). IEEE.
- [15] Pope-Ruark, R., 2012. We Scrum Every Day: Using Scrum Project Management Framework for Group Projects. *College Teaching*, 60(4), pp.164-169.
- [16] Pope-Ruark, R., 2015. Introducing agile project management strategies in technical and professional communication courses. *Journal of Business and Technical Communication*, 29(1), pp.112-133.
- [17] Rodriguez, G., Soria, Á. and Campo, M., 2013. Virtual Scrum: A teaching aid to introduce undergraduate software engineering students to scrum. *Computer Applications in Engineering Education*, 23(1), pp.147-156.
- [18] Rubin, K. S. 2013. *Essential Scrum*. Boston: Addison-Wesley
- [19] Schwaber, K. and Sutherland, J., 2017. *The scrum guide: the definitive guide to scrum: the rules of the game*. Recuperado de <https://www.agileacademy.nl/wp-content/uploads/2017/12/2017-scrum-guide-us.pdf>
- [20] Schwaber, K., and M. Beedle. 2001. *Agile Software Development with Scrum*. Englewood Cliffs, NJ: Prentice-Hall
- [21] Sommerville, I., 2015. *Software engineering*. 10th. In *Book Software Engineering*. 10th, Series *Software Engineering*. Addison-Wesley.
- [22] Staempfli, A., 2022. Knowledge Briefing: Enabling evidence-informed practice PSDP - Resources and Tools: Enabling evidence-informed practice. [online] London: Department of Education. Available at: <<https://practice-supervisors.rip.org.uk/wp-content/uploads/2020/01/KB-Enabling-evidence-informed-practice.pdf>> [Accessed 19 May 2022].
- [23] The Skills Development Scotland, 2021. *Graduate Apprenticeships*. [online] Glasgow: The Skills Development Scotland. Available at:



<<https://www.skillsdevelopmentscotland.co.uk/what-we-do/apprenticeships/graduate-apprenticeships/>> [Accessed 28 November 2021].

- [24] UKPSF, 2011. The UK Professional Standards Framework for teaching and supporting learning in higher education. [Online] Available at <https://www.advance-he.ac.uk/guidance/teaching-and-learning/ukpsf> [Accessed December 2022]
- [25] Vogelzang, J., Admiraal, W.F. and van Driel, J.H., 2019. Scrum methodology as an effective scaffold to promote students' learning and motivation in context-based secondary chemistry education. *EURASIA Journal of Mathematics, Science and Technology Education*, 15(12), p.em1783.
- [26] Vogelzang, J., Admiraal, W.F. and Van Driel, J.H., 2020. A teacher perspective on Scrum methodology in secondary chemistry education. *Chemistry Education Research and Practice*, 21(1), pp.237-249.
- [27] Vogelzang, J., Admiraal, W.F. and van Driel, J.H., 2021. Scrum methodology in context-based secondary chemistry classes: effects on students' achievement and on students' perceptions of affective and metacognitive dimensions of their learning. *Instructional Science*, 49(5), pp.719-746.

8. APPENDICES

Appendix A - Online Survey Result



Result_Table_V3.pdf

Appendix B - Sample Interview Questions

This study divides the interview questions into the following themes: Ceremonies, Roles, Artefacts, Monitoring and Tracking, Collaboration and Communication, and Reflection.

The interviews were held online with MS Teams with lecturers on the GA program. The main objective is to get insight into lecturers' and students' experiences with proposed agile and scrum practices. The interviews will be structured according to the following questions:

1. What do you know about Agile and Scrum. Are they the same or different concepts
2. Do you think that Agile and Scrum practices can be applied in teaching and research, and what would motivate you to use Scrum practices in teaching and research?
3. What factors do you think can hinder or facilitate the implementation of the Scrum practices in teaching and research?
4. Do you think scrum practices can affect (positive or negative) your teaching and learning style to students?
5. How do you think the different aspects of scrum practices, Scrum Roles, Artefacts, and Ceremonies, can be used to structure academic activities as teams.
6. What is your opinion about how corresponding scrum practices can be applied in academic activities to reduce the complexity of real-world questions by creating an

overview and transparency to improve teaching and research in the GA program?

7. What is your opinion about how corresponding scrum practices can be applied in academic activities to divide the complete assignment into smaller entities to improve teaching and research?
8. What is your opinion about how corresponding scrum practices can be applied in academic activities to visualise students' learning progress and inspect its quality to improve teaching and research in the GA program?
9. What is your opinion about how corresponding scrum practices can be applied in academic activities to reflect on their learning process and adapt mutual collaboration to improve teaching and research in the GA program?
10. Will you use scrum in future for teaching and research. Why?

Appendix C – A Framework for the Implementation of Agile and Scrum Practices in the context-based Teaching and Research in the GA program

Introduction

Scrum practices have been used in the teaching and research in secondary and tertiary institutions. The short report provides an overview of scrum practices in context-based teaching and research at the University of Dundee. This overview represents an explanatory framework of how scrum practices have been used in teaching IT Software Development in the GA program of the University of Dundee. This overview forms part of the documentation provided to students in the online survey that students have filed. The idea is to provide an explanation of how scrum practices have been applied in teaching and research. This will help them understand some of the other terminologies and concepts associated with agile and scrum practices. The overview was compiled based on my teaching and research activities in Term 2 of the 2021/2022 academic session in the GA program at the University of Dundee. Term 2 of the 2021/2022 academic session began in January to March 2022 and lasted for twelve weeks.

Scrum Implementation

The Scrum project in an educational context started with a teacher in the product owner role, presenting a real-world Software development concept (and associated questions) to his students with an explicit scrum ceremony. The scrum ceremony applied in this project is the sprint, which is likened to a period of three weeks for a unit of the Software development module.

The teacher provides students with scrum artefacts (e.g., scrum board and a product backlog). Scrum artefacts correspond to a list of teaching outlines, lesson objectives, exercises, and assignments necessary to answer the real-world question in teaching and research. The teacher clarifies the learning goals and connects the real-world question to the students' personal experiences.

Figure 1. Overview of Scrum methodology (Source: Vogelzang et al., 2019).



Students work collaboratively in groups, in which one student is the Scrum Master (the class rep), who takes the initiative to contact the product owner when problems arise. For example, the class rep might request on behalf of the class an extension of the submission deadline, a clarification of the assignment questions, or a specific resource to support students in delivering the assignment.

The class (group) works on a unit of software development module (and the associated real-world question) for approximately three weeks, with one lesson per week. The units are software requirement, software design, software implementation and software testing. The total software development module will last for a total of 12 weeks.

Each lesson starts with a stand-up ceremony (30 minutes of review of assignment and lesson questions) in which team members (the class) discuss their progress, problems perceived, and the current lesson's learning goals for the week.

The ceremony takes place in front of an artefact (e.g., a Scrum board), which basically consists of three columns named 'to do', 'doing' and 'done'. In teaching and research, this ceremony is likened to a lesson review that takes place in front of a projector screen that displays the assignment and then the lessons objectives (that is, artefacts (scrum board))

A Scrum board can be regarded as an artefact that provides an overview for students and teachers at a glance. The column 'to do' consists of all tasks, written on post-its, necessary to answer the main question. For teaching and research, the "to do" consists of all lesson outlines, lesson objectives, exercises, and assignments for the course.

For scrum, 'Doing' consists of the tasks in progress and when a task has been completed, it is positioned in the column 'done'. For teaching and research, 'Doing' consists of the specific questions in the assignment that have been covered in the lessons or the entire assignments for the software development module for the term. When an assignment question covered in the lessons has been completed, or the whole assignment is completed, it is positioned in the column 'done'.

The duration of the scrum project is divided into an equal number of iterative sprints to reduce the overall complexity of the real-world questions. Twelve weeks have been allocated to this scrum project (i.e., the teaching and research project, which translates to 12 weeks in the term). The twelve weeks are divided into four iterative 'sprints' of three weeks each,

reducing the overall complexity of the real-world question. The real-world question is: How can we develop a real-world case study of a web application based on the traditional software development processes? To address this real-world question, we divided the software development processes into four units – software requirements, software design, software implementation, and software testing- representing the four iterative sprints.

Finishing a sprint is done by releasing an intermediate product or by performing a formative assessment. In teaching and research, this is likened to submitting a class activity, completing a task in class, or a draft of the final assignment.

Reviewing and discussing comments and feedback based on the class activity and drafts assignments between the teacher and the class will improve the quality of teaching and research. Answering formative assessment questions helped provide insights into how well students understand the concepts associated with the real-world question. As a result, the teacher can tailor his instruction to the perceived difficulties of the students. This might mean providing more learning resources (e.g., tutorials and web links).

In the retrospective phase, the lecturer reflects on the learning process before beginning a new sprint. This is achieved in several ways, including discussing their mutual communication and other challenges they encountered. The lecturer chooses one specific point to improve in the next sprint cycle. In teaching and research, several areas of improvement include - organisation of the report using a proposed table of content, reviews and inspection of submitted artefacts (e.g., source code, diagrams). After finishing all sprints, the summative assessment (e.g., assignment marks) is released, which can be likened to releasing the ultimate product in a scrum project.

Conclusion

This report has discussed how to apply agile and scrum practices in teaching and research and explains its implementation in context-based teaching of IT Software Development in the GA program of the University of Dundee. This overview was based on teaching IT Software Development for one full semester. This overview was provided for lectures to read and understand before the interviews. For students, this overview was provided as part of the online survey (that is, as part of instructions) dot the students for the interviews.