From Formation to Evaluation: Optimising groupwork in STEM Degree Apprenticeships

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ABSTRACT

Engineering degree apprenticeships provide three to six years of job opportunities and training that lead to university qualifications up to and equivalent of a postgraduate degree. Within an apprentice's time in higher education (HE), many are required to complete groupwork projects which bring several benefits and some challenges. This paper explores the effects and limitations of group work in the context of degree apprenticeships whilst discussing a plethora of group selection and assessment method solutions. This includes student self-selection methods in comparison to teacher-selected and randomisation for group selection; a suitable method of selection should be unbiased and optimise advantages of collaborative working. Through understanding the most effective form of assessment for apprentices, an academic policy can be adapted and influenced – acknowledging the learning differences between undergraduate students and degree apprentices.

As part of this work, a comprehensive literature review was carried and a survey was conducted and completed by the Bsc Digital and Technology Solutions students, BEng Applied Professional Engineering Programme students among others at the University of Warwick. The results of the survey provided quantitative and qualitative data surrounding group work.

Furthermore, the paper suggests appropriate solutions to group work issues surrounding the effectiveness of group work for degree apprentices, optimal group selection-methods, group performance, ensuring equal contributions and assessment and grading methods. The paper addresses some of the problems encountered by apprentices during their studies such as the

free-rider problem and unequal division of work - providing solutions towards minimising such problems, including the integration of web-based tools such as MS Planner.

INTRODUCTION

A new strand of education is developing with the introduction of Degree Apprenticeships (DA). These apprenticeships offer the opportunity to gain a Higher Education (HE) degree while being employed in a role that is aligned with the degree, a way that is pivotal in refining the nation's skills (Ross and Riley, 2018). With Degree Apprenticeships, the traditional life of a student changes. These students do not have the physical community of the campus. Their campus visits are in intensive blocks, which is restrictive in their social opportunities.

Groupwork forms an important assessment method in education that helps apprentices to break down complex tasks, improve collaborative learning, manage time and demonstrate leadership (Jacobs and Ward, 2000). In addition to the known problems (Davies, 2009), the nature of the Degree Apprentice part-time model brings some additional challenges regarding forming relationships with peers.

Degree Apprentices face groupwork problems surrounding unequal workload divisions, disruptive behaviour between close peers and free riders (Clarke and Blissenden, 2013). To find an appropriate solution to the problem, research into student beliefs surrounding these issues has been conducted in the form of a survey questionnaire which is then comparable to a literature review to deduce the most effective groupwork practices.

LITERATURE REVIEW

Degree Apprenticeships are level 6 or 7 qualifications equivalent to a bachelor's or master's degree, which combine academic study and working within the industry. As of April 2017, the government introduced a degree apprenticeship levy to incentivise employers through allowing them to reclaim 0.5% of their annual pay bill to cover the training and tuition costs of apprentices. In the 2021/2022 academic year, there were 88,200 apprenticeship starts within HE (Department for Education, 2022a).

The Skills Funding Agency (SFA) cites the drivers behind the apprenticeship scheme as to improve productivity, force employers to invest in high-quality training, improve social

mobility, create more opportunities for young people and for university and business collaboration (Ross and Riley, 2018). There are benefits for employers, students and universities within degree apprenticeships. For employers, they can train students with company-specific skills and values at a graduate level to create a pipeline of talent within the organization. Furthermore, enabling recruitment from the existing workforce allows skill gaps to be filled both within the company and industry (Department for Education, 2020). For students, a degree and relevant industry work experience are gained with the benefits of no student debt, yearly income and a high level of employability. Academic Institutions receive increased enrolment with stronger engagement with local businesses, increasing local economic impacts in the long run.

However, university staff report challenges surrounding staffing, resources and administration. Degree apprenticeships were reported to require substantial additional administration in relation to employer and stakeholder agreements whilst universities face challenges hiring staff with practical experience to fit within timetabling agreements with employers – with inductions and industry placements effecting staff working hours (Lester and Bravenboer, 2020).

There are many advantages to group work for students, where Jacobs and Ward (2000) explain five important 'principles' of group learning. These include interdependency, accountability of sharing knowledge, collaboration, equal opportunities and the ability to learn together. Students can also put the core societal values into practice and exhibit democratic behaviours.

Beebe and Masterson (2003) claim that an advantage of groupwork is an individual's opportunity to gain a better understanding of themselves, with feedback allowing for personal growth and evaluation. Furthermore, the decision-making initiatives required within group work improve problem-solving skills to make decisions whilst keeping them engaged with their learning and understanding with high satisfaction from the group. A paper by Barkley et al., (2014) explores how people retain information learnt in group discussions better, as group learning 'fosters learning and comprehension' in comparison to learning the same information through different resources.

Moreover, representations of teamwork are valued by employers, and are seen as a top ten skill for graduates to have – therefore students gain experience and are prepared to join the labour force. Furthermore, a report commissioned by the Higher Education Council of Australia identified teamwork skills as one of the 'valued transferable skills' within undergraduate courses (Candy, et al., 1994).

There are obstacles involved within group work scenarios, with the 'free circulation of ideas' limited. When groups discuss concerns, pressure is generated toward solution and agreement, which although keeps the harmony, can limit further ideas being presented therefore members of a group may feel less incentivised to share (Douglas, 1993).

Hoffman (1965) believes the biggest obstacles to group performance to be personal characteristics including: lack of confidence in judgment, agreement to obtain likeness from other members, insecurity of idea rejection, inflexibility to new approaches as a previous approach worked and the impact of those who are the most 'liked' and 'talkative' having a higher influence on group performance. There are several external constraints that Hoffman (1965) argues affect performance, including material – with the necessary equipment to be accessible by all members of the group, to prevent some apprentices having advantageous materials. This includes paid-for resources, access to additional teacher support or access to technology. Research has found cooperative learning is more efficient when using online learning tools, with the integration of technology stopping members of the group from being limited by proximity, therefore increasing collaboration time (Groff, 2013).

A case study at the Chalmers University of Technology in Sweden asked Engineering students and teachers for their thoughts on group work at an Undergraduate and master's level. Teacher feedback suggested disproportionate submissions are the result of students having problems with 'divisions of the work', with some groups splitting work unevenly and others 'reluctant to divide the task at all, trying to do everything together', highlighting that lecturers need to make the task division more apparent (Christie & Ferdos, 2006).

Clarke and Blissenden (2013) suggest the reasons students dislike group work is due to the assessment criteria, in which they believe they have not gained a mark sufficient for the quality of their work as they did more work than their peers in the group. Other reasons include the 'free-rider problem', in which some students made little or no contributions to the project yet expect the same grading as their peers, with their suggested solution picking their own group members, although this does not fully prevent the issue.

Group selection can be determined through randomisation, in which randomisation must be independent and generated through a robust process, such as computer software. Concealed randomisation refers to all participants having no foreknowledge of the randomised allocation and can be achieved using computer software (Torgerson and Torgerson, 2013). It's vital randomisation is 'locked' to prevent reallocations and selection bias from staff. Selection bias is where randomisation is not achieved, and the sample is unrepresentative of the population being analysed, this can occur when a vested interest is present, emphasizing the importance of concealed randomisation. Advantages of randomisation include heterogeneity maximisation within the group, theoretically increasing the range of backgrounds and experiences of

students (Davis, 1993). However, the class may contain a large imbalance of gender, race, ethnicity and educational attainment in which heterogeneity is low. The latest figures from Engineering UK (2023) demonstrate 66.1% of Engineering students are white and only 18.5% identify as female within HE. This is notably below the average of 56.5% female representation across all subjects, which should be considered when choosing randomisation methods when aiming to increase group diverseness.

Typically, students who seek self-selection methods are higher achieving individuals who have had prior academic interactions with one another (Chapman et al., 2006). This is reinforced by research from Oakley et al. (2004), that students choose group members of their own perceived academic level, which reduces the benefits of groupwork where students can peer learn from each other, resulting in academic homogeneity. Furthermore, in situations where group members are friends, students can become distracted from the main task with a debilitative tendency to socialize alongside a 'lower acquisition' of social skills (Mitchell et al., 2004).

However, results showed grades assigned to the groups didn't differ based on group formation but correlated to degree of participation within the project and task interdependencies. Therefore, achievement had a higher correlation to individual group member performance and participation, but conditions must allow each student to demonstrate their competence.

In consideration to assessment methods, Rafiq and Fullerton (1996) believe students should use peer marking methods and consider their peers' performance in relation to their overall level of participation, their understanding of the task and requirements, their ability to suggest ideas, consolidation of ideas and sorting out issues both within the group. This provides an alternative assessment method solution to group work issues discussed by Clarke and Blissenden (2013).

Peer review must be objective, impartial and honest to be a successful assessment method. The integrity of peer review can be maintained by a lecturer encouraging honest and respectful feedback, including praise and criticism which must remain professional and not personal. To reduce bias, students must be aware of bias and bring problems to the attention of their supervisor if they believe there to be a conflict of interest or bias present (Steneck and Kolstoe, 2020).

To gather an average grade for a group, several students within the group should peer review each other's work to gauge an average grade, therefore, anomalies and unfair reviews can be detected.

Fellenz (2006) explores a regressive grading formula to reduce the weight of very high or very low peer reviews, to avoid unfair grade inflation or deflation. Students receive a grade assigned for their group project (Q) as well as peer-evaluation 'points' (P) from all members in the group. To prevent grade inflation, the maximum difference between Q and their individual grade is determined by the teacher (d), before a regressive formula is applied if the maximum is surpassed. The weighting of the group quality grade to which peer evaluation is applied is also determined by the teacher (x). Results are composed from a group component (G) and Individual Component (I).

Formula (1) shows the regressive formula used when a distinctly low peer evaluation score is given:

$$I(low) = (x/2 \times Q) + (x/2 \times Q \times P/100) - d/2 \qquad (1)$$

$$\text{Final individual Grade} = G + I(low) \qquad (1)$$

In the event the formula calculates the final individual grade by adding the group component and individual component, which can be done without regressive grading when the maximum difference is not surpassed, as seen in Formula (2):

$$(G + I) - Q \leq d \qquad (2)$$

However, a student could withhold a peer review - in the event of this, precautions should be implemented to avoid grade deflation. Where 'points' haven't been allocated, a middle value should be determined which doesn't inflate or deflate other peer reviews within the group, therefore final individual grades are not impacted. Although, students should be encouraged to review fairly and to not collude on marking.

Marcia Delvin of Victoria University Melbourne (2004) explores assessment options for lecturers of group work. One option is using individual marks based on records and observations of the process, this can be predetermined in a criterion to collate evidence from 'team logbooks, minute sheets and direct observations of the process'. An advantage of this method is that logs and minute sheets help members focus on the process and ensure work is completed during appropriate timeframes. Additionally, this method can prevent 'free riders' as they are required to log their contributions. However, issues can occur surrounding training students to keep accurate and reliable records. Furthermore, this could be time consuming for a lecturer to review without an automated system.

AIM AND OBJECTIVES / RESEARCH QUESTION(S)

The primary research aim is to explore how STEM Degree Apprentices perceive Groupwork and how it can be assessed fairly within HE, to provide fair grades for apprentice contributions. The objectives involve a literature review to gather secondary data, followed by the creation of a survey to distribute to degree apprentices to gather primary data thenceforth the creation of data visualisations, analysis and comparisons to suggest suitable online collaboration tools and further research.

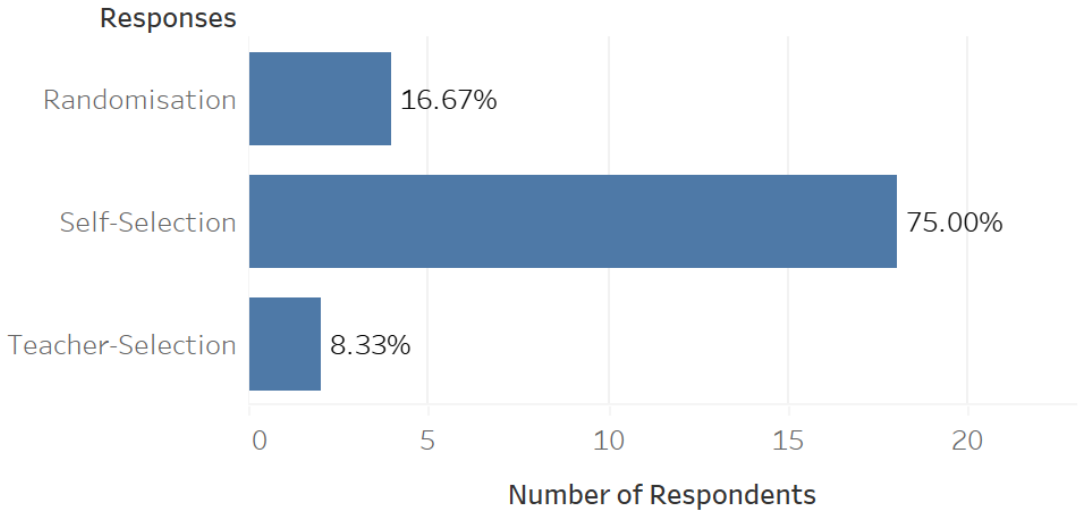
METHODOLOGICAL APPROACH

The researcher surveyed degree apprentices at Warwick University, including: Bsc Digital and Technology Solutions students, BEng Applied Professional Engineering Programme students and any other degree apprentices. The aim of this survey is to gain primary quantitative data surrounding group work as a lot of publications surrounding group work do not consider educational changes post COVID-19 Pandemic, as digital methods are utilised. The survey was completed using 'Qualtrics', an online survey tool in alignment with the Warwick University research guidelines and will not collect personal, identifiable information ensuring participants anonymity aside from their course – containing 11 questions answered by 24 apprentices. Furthermore, this tool validates candidate responses are real and participants must complete CAPTCHAs to proceed. A survey format allows respondents to share honest opinions they be uncomfortable with sharing in a classroom format in front of peers, with the multiple-choice questions prompting thoughts for further discussion in the qualitative question. The questions focus on preferences to gather information on apprentice satisfaction and how this effects workflows with peers, ultimately impacting their overall grades. The research period lasted 3 weeks to allow the maximum number of participants to respond, with several weeks to analyse and visualise data after. Anticipated shortcomings surrounded a low level of responses, as it was not compulsory, although resolved by lecturers redistributing the survey in the future.

KEY FINDINGS

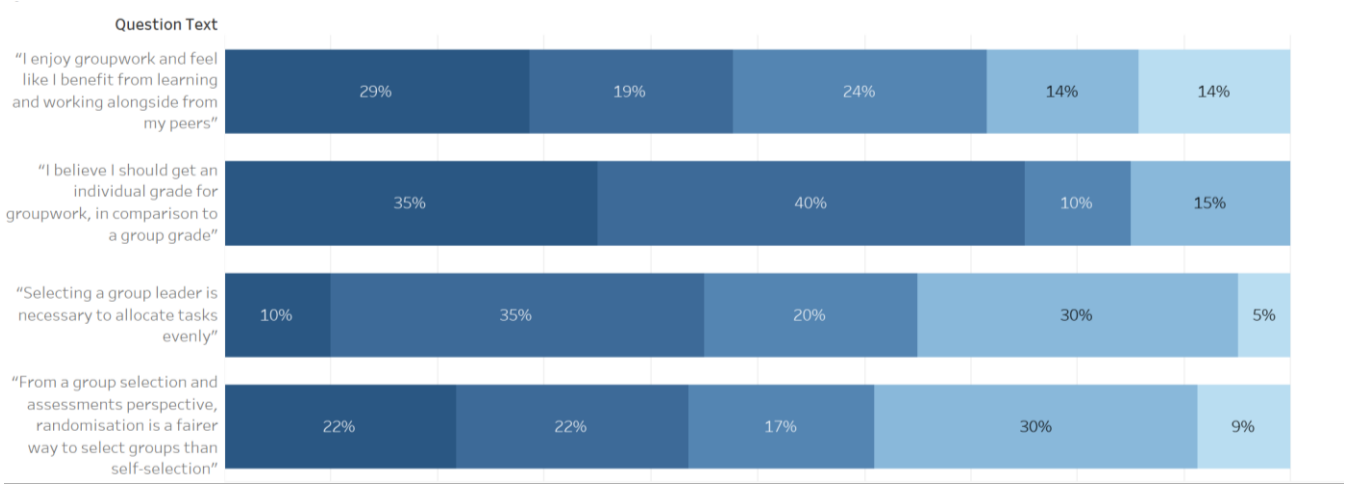
As previously acknowledged within the literature review, students often opted for self-selection methods, as they were aware of the academic performance of their peers as well as prior friendships. Results from the survey reinforced these findings, with 75% of respondents claiming to prefer self-selection methods over randomisation and teacher selection.

Figure 1. "Do you prefer to self-select, teacher select or randomise group members for groupwork?"



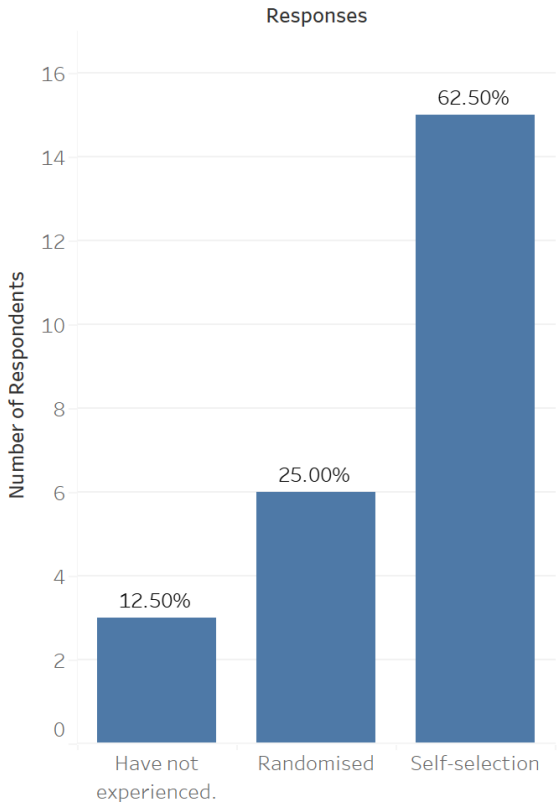
When asked 'to what extent' respondents agree with the statement 'From a group selection and assessments perspective, randomisation is a fairer way to select groups than self-selection', 44% of respondents believed randomisation is a fairer method to select groups over self-selection, with 22% stating they strongly agree. These results adhere to prior research surrounding selection bias when teacher-selected groups are formed as well as self-selection methods minimising academic heterogeneity. Although, the majority of degree apprentices believe self-selection is a 'fairer' method which influences assessment method types used- as if self-selection methods are employed, peer review could be less objective within groupwork without intervention or education on how to conduct unbiased, impartial reviews.

Figure 2. Q4 - This question focuses on a range of 'To What extent do you agree' statements



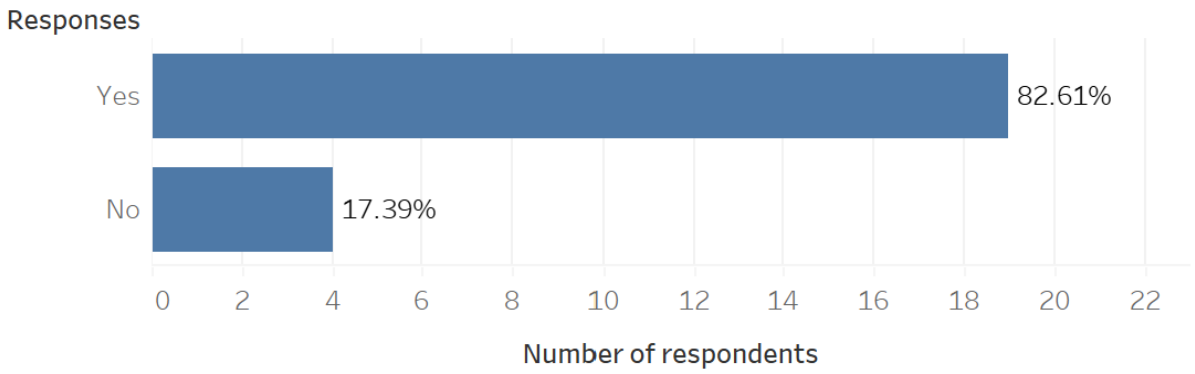
Interestingly, 63% of respondents claim to have faced the least disruptions when working within self-selected groups in comparison to 25% of respondents saying randomisation has caused the least problems. These findings contrast initial beliefs, as self-selected groups experience more off-task disruptive behaviour, criticism reluctance and pressures to agree and conform with friends (Dutson et al., 1997). However, it's possible degree apprentices with pre-existing academic friendships from the workplace have positive experiences due to feelings of loyalty and mutual liking of each other, spending more time with their peers than undergraduate students – at average 30 hours week in contrast to 21 hours respectively (UCAS, 2022; ThinkStudent Ltd, 2022).

Figure 3. "What method has caused the least disruptions and problems within groupwork in your course?"



A method proposed to support accurate grades being allocated was the creation of meeting logs, where students provide evidence to their lecturer about their personal contributions to the task. Overwhelmingly, 82% of respondents agree meeting logs encourage more equal contributions, permitting researchers to look into suitable arrangements.

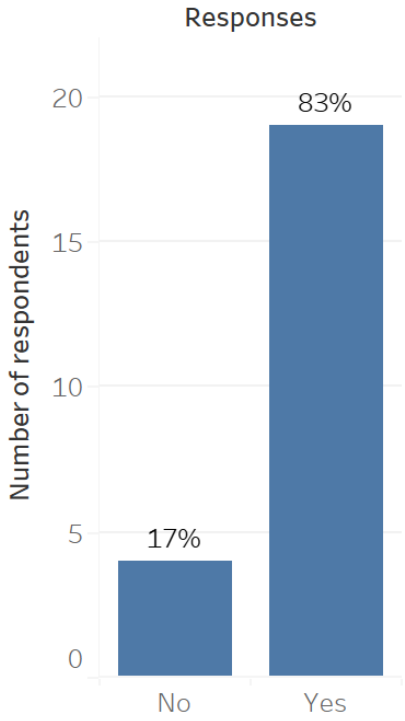
Figure 4. Do you believe that having students record meeting logs encourages more equal contributions for the group from all members?



A proposed method to develop meeting logs is to use online applications such as MS Planner. The platform contains many features applicable to degree apprenticeship courses that allow both lecturers and students to monitor groupwork progress. The platform allows users to create a 'Plan', which is a project which involves multiple smaller tasks. Users are then required to create a 'group' in which the plans are shared throughout all members added – including a lecturer. The main 'board' within the application contains a to do list, tasks and buckets, which is a tool to group similar tasks together allowing degree apprentices to separate their tasks whilst being able to view other members tasks. Individuals can be allocated tasks and are then responsible for completion of it in line with the due date set. Furthermore, labels can be attached to tasks as well as checklists – giving visual aids on the progress made whilst comments and attachments are a feature if a document needs to be uploaded to the planner. Filters are available, where all members of the group can view who has been assigned what tasks, and which are for everyone to complete – meaning degree apprentices have evidence if a free-rider attempts to not complete their work.

Degree Apprentices were asked if they "believe such logs should be developed and maintained via an online platform such as MS Planner, where the group's supervisor has access to it throughout the project?" to which 83% of respondents said Yes.

Figure 5. Do you believe such logs should be developed and maintained via an online platform such as MS Planner, where the group's supervisor has access to it throughout the project?



DISCUSSION

Quantitative data shows 59% of respondents identified the free rider problem as their biggest groupwork concern, selecting the statement 'The Free Rider problem, where an individual does not contribute as evenly as the rest of the group'. An unequal division of tasks was selected as the second biggest concern, with 24% of respondents recognising this as an issue. 10% of respondents identified concerns surrounding the domination of discussion from members of the group, leaving them feeling unable to discuss new solutions.

Qualitative data collected from respondents surrounding their biggest concerns in groupwork expressed students' distaste for 'success being dependent on others completing their work', as contributions to a 'poor standard' means other students have to 'suffer'. Additional comments express disfavour of division of tasks, with desire to 'contribute to all aspects of a task' emphasising in STEM subjects that some are more capable within technical areas than others. Furthermore, one individual identified the unequal gender splits within the groups as 'awful' and 'sexist comments' were expressed when in large groups. This cannot be avoided when groups are formed using simple randomisation with no human input, especially in STEM subjects with large gender imbalances and low heterogeneity – despite how randomisation can maximise it. In groupwork situations where self-selection or teacher-selection are utilised,

enforcement of more equally sex split groups can be created, facilitating towards under-represented groups.

The use of MS Planner was explored, with an advantage being its synergy with Microsoft Outlook, as an email section is created for the group within Outlook where all reminders and communications are sent, allowing updates, meeting invites and notifications to be sent to group members. Synergy with Microsoft Word mean documents can be opened through SharePoint and all document edits are reflected in an edit history. As Microsoft 365 features are web-based they can be accessed on all devices, not limited to a specific operating system or device therefore maximising the number of students who can access the project.

Another feature is the 'Charts' section, which creates visual aids of task completion – including whether a task has been started, is in progress, is late or completed. As 'priority' can be assigned to tasks, all users can view what 'urgent' tasks there are and whether they've been completed – enabling MS Planner to notify students instead of them having to hurry other students up, potentially reducing conflicts and heated discussions if a student is running behind schedule. To ensure the workload remains balanced, tasks per member can be viewed and their status – meaning students can ensure equal contributions are being made and monitored. Microsoft Calendars are also updated with tasks, viewed as the 'Schedule' tab within MS Planner, where students can add meeting dates, tasks or notify other members the days they are unable to work.

A disadvantage of MS Planner is team availability is not automatically synced to personal calendars, therefore, students are required to communicate on when to schedule meetings. In addition, there's currently no feature to set recurring tasks for the group and tasks are limited to a maximum of 10 per task. In the event of a large project, this could prevent apprentices scheduling their tasks ahead of time, but ensures they return to the platform to update it, therefore viewing their personal and team progress.

To create 'logs' by the end of the project, MS Planner can convert data to Microsoft Excel, creating a spreadsheet with the dates of the created tasks, the start date, the end date, the completion date, who was assigned the project, a description of the task and whether checklists were completed. This reduces the need for students to create portfolios and personally derive evidence of work, as it automatically collates. Furthermore, the data cannot be manipulated without edit history showing, therefore enforcing reliability which students completing logs themselves may not have, being dishonest about when work was completed. Further information on the tool can be found on the Microsoft 365 webpages (Microsoft, 2024).

CONCLUSIONS & RECOMMENDATIONS

The paper finds that degree apprentices are overall satisfied with the use of group work, with the highest satisfaction when self-selected groups are used, in which students believe they face the least problems in comparison to teacher-selected or randomised group selection methods. As apprentices begin to form relationships with their colleagues within their company, who may be within the same department or have the same shift patterns – they naturally may have preferences to work in university groups together. However, the problem identified as apprentices biggest concern was the free-rider problem which is more likely to be prevalent within a self-selected group work setting due to apprentices making excuses for their friends when work is not completed or to a high standard. A randomised group selection method could reduce this, as students get put into groups which are less likely to contain their immediate friendship groups. However, issues with randomisation arose when imbalances of gender were prevalent within groups in STEM Subjects, and direct input from staff to amend this would reduce the benefits of randomisation and cause selection bias, which more research should be conducted into.

The paper also concludes that surveyed apprentices were satisfied to receive individual grades rather than a group awarded grade as a form of group assessment, recognising their individual contributions which is supported by favourable use of logs which include minutes sheets, to created evidence-based assessments alongside peer reviews. Logs can be created using platforms such as MS Planner which makes completed and non-completed work visible for both lecturers and students, monitoring progress for when peer reviews are conducted to ensure fair reviews and marks have been awarded. Furthermore, students believe all members of the group should take responsibility for completing the logs, rather than a group leader conduct it all. A combination of these methods will result in degree apprentices having a smoother groupwork experience.

Future research conducted into optimal online collaboration tools will allow institutions to view the correlations between apprentice preferences of group assessment and the effectiveness of online collaboration, and whether higher levels of apprentice group satisfaction led to a stronger work ethic at university and the workplace to increase educational attainment.

Existing research into the use of Microsoft 365 and Planner by Glazunova et al. (2017) with researchers and educators deduced from a questionnaire that the platform increased student's hard skills in the field of IT, soft skills through their time management and leadership confidence whilst facilitating collaboration and connectivity. Therefore, a trial period of enforcement of MS Planner tools into degree apprenticeships can create further comparisons

for researchers over multidisciplinary subjects and course types, such as Engineering, Computer Science and Maths to conclude the effectiveness of online cloud collaboration tools over traditional classroom groupwork for degree apprentices.

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