Article

Making the Most of Cognitive Surplus: Descriptive Case Studies of Student-Generated Open Educational Resources

Mais Fatayer [1] and Eseta Tualaulelei [2,*]

1 The Institute for Interactive Media & Learning, University of Technology Sydney, Ultimo, NSW 2007, Australia; mais.fatayer@uts.edu.au
2 School of Education, University of Southern Queensland, Toowoomba, QLD 4350, Australia
* Correspondence: eseta.tualaulelei@usq.edu.au

Abstract: Universities are hives of knowledge production and innovation, but the work students produce for assessment is often utilised in a limited way, neglecting a potentially rich intellectual resource. This article investigates an activity that can make use of this resource. It has known benefits for students but is rarely used in higher education—student-generated open educational resources (OER). In descriptive case studies of two projects where students created OER as an assessed part of university coursework, the article explores the impacts of this activity on students' learning experiences and the educational practice of teaching academics. Drawing upon social constructivist understandings of teaching and learning and a range of quantitative and qualitative data from projects with 156 students and 3 academics, the descriptive case studies illustrate how student-generated OER, guided by an OER development model, positively benefitted learners and educators. The discussion balances these benefits against some of the challenges experienced in the process. The article will argue that student-generated OER could be widely used, but specific supports are necessary for academics to facilitate this activity successfully.

Keywords: open educational resources; student-generated OER; higher education; open pedagogy; OER-enabled pedagogy

1. Introduction

Every year, university students across the globe create essays, presentations, and other learning artefacts to fulfill university course requirements. Many courses require students to submit projects evaluated by their teachers, who assess and return them, often with feedback. However, the process remains in a closed circle of the student-to-teacher relationship, which other students rarely benefit from [1]. To harness the knowledge that results from traditional university assignments, Wiley and Hilton [2] recommended the use of 'renewable assignments—assignments which both support an individual student's learning and result in new or improved open educational resources that provide a lasting benefit to the broader community of learners' (p. 137). The idea is appealing. If university assignments required students to create artefacts of learning that are also artefacts for sharing as open educational resources (OER), the benefits could accrue far beyond a student within a specific university course, for instance, by reducing student textbook costs and expanding access to higher education [3]. Research (i.e., [4–7]) confirms that OER lead to greater sharing and availability of specialist knowledge and resources, innovations in curriculum, new perspectives of knowledge repositories and frameworks and increased use of technology. These evidence-based benefits support the idea of incorporating student-generated OER into university teaching and learning activities.

However, student-generated OER are rare in higher education practices, and there are few detailed examples to guide this practice. Academics and institutions generally lack an awareness of OER, which may be due, in part, to the lack of terminological clarity

in the field of open education. In a conceptual paper outlining eight factors to take into consideration when transitioning towards open education, McNally and Christiansen [8] argued that the term 'open' is ambiguous and the lack of clarity about the relationships between OER, open educational practices (OEP), and open pedagogy have obfuscated the main priority of OER: pedagogy. In other words, without clear benefits for teaching and learning, universities may be hesitant to fully invest in the open educational movement. A further complexity is that some regions lack public policies and frameworks supporting OER in education [9,10], making it difficult for universities to prioritise open educational practices when they see no definitive aims, rationales, principles, or evaluative guidelines. Clearly, there is much work remaining for open education to be mainstreamed into higher educational practices.

Using insights from descriptive case studies, this article shares a model that can help guide academics in creating OER with their students. The article begins by outlining the practical and theoretical rationales for student-generated OER. Then, it describes the design and data of two projects conducted by the authors, where a model for OER development was trialled and developed over several university courses. Evidence illustrates how the OER development model promoted students' academic and professional outcomes and enhanced educational practice. We argue that student-generated OER are an effective way to use the cognitive surplus of students for wider societal benefit, but various types of support are required for academics to facilitate the activity.

1.1. A Practical Rationale: Student-Generated Content

The 'student-generated content' concept was derived from user-generated content and emerged in formal learning environments [11]. Other terms that refer to students generating different types of multimedia through their learning process include 'learner-generated content' [12] and 'student as producer' [13] and these are used in different teaching approaches such as project-based learning, group work, and reflection activities. In higher educational institutions, these activities represent a form of 'cognitive surplus', a term Shirky [14] used to describe the abundance of small contributions people make collaboratively through social networking software tools. Shirky [14] argued that contemporary technologies allow cognitive surplus to be captured faster and on a much wider scale than ever before. For students, using their cognitive surplus can provide 'value' for the hours of cognitive effort they invest in their studies [15]. This points to the potential for cognitive surplus, such as student-generated content, to have impacts beyond the activity for which the content was created.

These impacts may compound when student-generated content is combined with OEP, 'defined as practices which support the (re)use and production of OER through institutional policies, promote innovative pedagogical models, and respect and empower learners as co-producers on their lifelong learning path' [16] (p. 12). Wiley and Hilton [2] exemplified this combination with their idea of 'renewable assignments', which are openly licensed artifacts that have been student-generated. Openness is non-negotiable with renewable assignments [2,17], for without an open license, students' work cannot be shared and reused by others. This shift towards accessibility and knowledge-sharing was described by Paskevicius and Irvine [18] (p. 8) as a manifestation of learning design 'largely drawing from existing models of constructivist and networked pedagogy that prioritise the interests and voice of the learner'. However, their perspective contrasts with Bali et al. [19], who claim that OEP may range from teacher-centric to learner-centric practices, content-centric to process-centric practices, and primarily pedagogical to primarily social justice-focused practices. Whichever approach teaching academics employ, from creating open textbooks [20] to using OEP incidentally [21], there is a consensus in the academic literature that openness in education has positive effects on teachers and learners in higher education [18,22].

Previous research evidenced the significant impact of student-generated content in enhancing students' learning and professional development. Student-generated content

engages students with what they are learning [23–25], and it may also enhance students' learning performance in summative assessment [23] and student satisfaction [26]. Benefits have also been seen in students' digital literacies and their persistence and motivation to learn [11,22]. Additionally, when students engage specifically in generating educational resources, the benefits can extend to their professional or societal development [12,27]. For example, Snelson [28] found in a scoping study that creating videos as a type of digital authorship allowed students to develop multiliteracies and practical skills in generating educational resources, skills that would be valuable as students progressed through their careers. Similarly, Abas [27] reported on the value of student-generated OER, in this case, openly licensed comics, for promoting justice-oriented teaching practices.

The benefits of student-generated content have become more prevalent due to the accelerated development of technologies for the learning process. A wide range of content-generation tools allows students to participate in collaborative learning activities through applications such as blogs, wikis, social networking sites, online games, online video sharing, and immersive virtual environments [29]. At the same time, students studying higher education online expect an individualised and flexible learning experience [30], so teachers use technologies to add these qualities to the learning experience and to enhance students' digital literacy. These days, most learning environments have adopted technologies to facilitate active and participatory learning. However, teachers should be guided by a clear understanding of how specific technologies aid learning within a discipline area [31], and they are interested in both the technology and 'purposeful learning design in support of openness' [32], signalling the need for models to guide teacher practices. A few researchers have noted the limited available research exploring OEP and communities [33,34], suggesting this is a ripe area for investigation. Moreover, in a review of the literature published between 2009 and 2018 about OER, Luo et al. [35] did not find any models or frameworks for OER implementation (also see [36]). They wrote, 'evidence-based research studies that specifically provide models of implementation and best practices for institutions, as well as for individual educational practitioners and/or learners would be extremely helpful' [35] (p. 154). To this end, the generation of student content would benefit from a learning design model that provides clear guidance and has been field-tested, particularly for content that eventually becomes OER.

1.2. A Theoretical Rationale: Social Constructivism

Constructivist definitions of knowledge and learning are well aligned with the activity of student-generated OER development. In this perspective, knowledge is an emergent and developmental product generated by human engagement in meaning-making in cultural and social communities. In contrast, learning is a constructive activity in which learners take ownership and responsibility for their learning and interpret the world according to their personal reality rather than being passive receivers of knowledge [37]. Previous research (e.g., [38–41]) has shown the effectiveness of applying constructive learning activities in technology-enhanced learning. This is due to learning taking place in a real-life setting [42] where students engage in building learning resources as part of the requirements of university courses.

Constructivists differ, however, on the value of social interaction in this process [43], so social constructivism offers a perspective that stresses the fundamental role of social interactions in acquiring skills and knowledge. Social constructivism holds that individuals learn through interacting with other individuals and with the environment [44,45]. In this perspective, learning activities should occur in socially meaningful contexts that allow knowledge to be cognitively mediated between two or more people. In other words, learning happens during the process of student-generated OER when students negotiate knowledge with academics, fellow students, and others. Students then become part of a learning community, which may be of particular benefit to students who study online or at a distance, and they may share their developing knowledge beyond those grading their assignments.

Having established a practical and theoretical rationale for exploring student-generated OER, this study was designed to explore the following research questions:

1. How does student-generated OER following an OER development model impact students' learning experiences?
2. In what ways does involving students in generating OER help improve educational practice?

2. Materials and Methods

This study employed a descriptive case study approach of two projects from two Australian universities. The descriptive case study approach is useful when projects sharing the same goals are conducted in different sites, but analysis of similarities and differences can provide insights into causes, outcomes, or impacts [46]. Approvals from each university's ethics committee were obtained before the projects proceeded. Participants for both studies were selected using purposive sampling, an appropriate method for maximising the usefulness of data obtained from a small sample and the limited period of each project [47]. The limited time period also dictated the number of research cycles each researcher could conduct within their research designs. The two projects are summarized in Table 1 and described in more detail below.

Table 1. Summary of projects.

	Case Study 1	Case Study 2
Courses	Computing Engineering Mathematics	Education
Study level	Undergraduate	Undergraduate
Data collection period	2012–2013	2019–2020
Research approach	Design-based research	Action research
Cycles of study	5	2
No. of student participants	89	67
No. of staff participants	2	1 (author 2)

The project in Case study 1 was conducted by the first author as a researcher and academic tutor in three undergraduate courses at the School of Computing, Engineering, and Mathematics in a multi-campus university in New South Wales, Australia. It was guided by a design-based research methodology, which is iterative in design, implementation, analysis, and refinement [48]. The research ran three iterations (one cycle during Iteration 1, one cycle during Iteration 2, and three cycles during Iteration 3) over three academic semesters between 2012 and 2013. The data in this paper are from Iteration 3, where the OER development model was refined, and the final design principles of the model were generated. In each iteration, students developed learning resources as part of the assessment requirement of the units. In cycle 3, students developed learning resources based on a topic of their interest in computing studies. For students enrolled in advanced subjects, cycles 4 and 5, students developed learning resources based on a topic from the unit of study. A new rubric was generated during the research project and embedded into the three cycles. Students used the rubric as guidance for generating the learning resources in cycle 3 and for guidance, as well as a peer review instrument for cycles 4 and 5.

Case study 1 research participants included course coordinators and students from Cycle 3, Introduction to Information Technology—a first-year course; Cycle 4, Foundations of Statistical Modelling and Decision Making—a second-year course; and Cycle 5, Data Mining and Visualisation—a third-year course. The researcher and course coordinators redesigned a project-based assessment component in each course to integrate the OER development model. Data for Case study 1 were collected over 3 months (August to November) in 2013 through pre and post-surveys of 89 student participants and interviews with two course coordinators. A total of 43.8% (*n* = 39) of students responded to the

pre-survey, which asked questions about general internet technology experience, content-authoring software skills, creating and sharing content, and incentives for creating and sharing online. A total of 37.1% (*n* = 33) of students responded to the post-survey, which asked about the quality of students' generated learning resources, whether their resource was published, the time required to generate it, and the type of licence it was published under. Further data were captured through interviews to understand course coordinators' perspectives about integrating the OER development model in the learning environment.

The project in Case study 2 was conducted in a third-year undergraduate education course facilitated by the second author at a mid-size regional university in south-east Queensland, Australia, with over 75% of students studying online. This project was funded by an open educational practice grant for exploring the use of open assessment in higher education. It utilised action research methodology [49], which was selected because of its capacity to create adaptive solutions for practical problems, aligning with the aims of OER. Two cycles of research were conducted over two academic semesters in a course about intercultural communication in early learning contexts. Although creating OER was assessed as part of each student's final course grade, open publication was only offered after the course ended as a voluntary activity without credit. Students produced two collections of OER [50,51] that responded to practitioner concerns about issues in intercultural education. Full details of the task students had to complete, including the assignment instructions, are available in the OER, and these resources are used by students enrolled in the course and by in-service professionals. Data were collected for 12 months, from November 2019 to November 2020, and 67 students participated in the research. Data were captured through qualitative feedback from students through course evaluation data, student reflections, and communications about the OER task, and quantitative data were captured through learning analytics.

Qualitative data from both projects were brought together for analysis, which examined the data for themes relevant to the research questions. These themes were confirmed through triangulating the different data sets within each project and across the two projects. Quantitative data from surveys and learning analytics were analysed using descriptive statistics and correlated with the qualitative themes.

3. Results

3.1. Case Study 1

At the outset, a model (detailed in [52]) was proposed where students developed OER as learning artefacts through a three-step process involving (1) building content, (2) evaluating student-generated resources, and (3) publishing student-generated resources as OER. As part of the model, students participated in two technical workshops to raise their knowledge of OER, Creative Commons licences, and content-authoring tools. These workshops took place relatively early in the academic semester (week 4 of a 15-week semester) and covered the following areas: (i) value of OER and OEP in higher education, (ii) intellectual property issues and use of Creative Commons licences, (iii) process of OER development where students were introduced to the OER development model, and (iv) examples of student projects from the previous two semesters and in-class discussion to share feedback and ideas. In the pre-survey conducted before the workshops, where students were asked about their experience with creating and sharing online content, 21% (*n* = 8) said they had published work online, 15.4% (*n* = 6) said their work could be used as learning resources, and three students gave genuine links of their work. Students selected 'being connected with others', 'sharing knowledge', and 'help others learn' as the top incentives for them to create and share online resources.

Students' responses to the post-survey showed that in terms of sharing their work online, 39% of students wanted to share their learning resources, and 36% had already put their student-generated learning resources online. This indicated that the model was successful in helping students share their work. However, almost one-quarter of the students did not want to share their learning resources, perhaps due to the effort involved.

When asked about the time spent developing their resources, 19 students (58%) said their previous technical skills helped them, and 14 (42%) said they needed further technical scaffolding. Over 80% of students spent equal or more time learning the content-authoring software tools than developing the resource, highlighting that technical scaffolding is essential to the process.

Themes drawn from course coordinator interviews pointed to four key benefits of the activity for students' learning experiences. One theme was that coordinators saw increased student confidence from students who published their work online. A further theme was that the OER activity provided an enhanced personalised learning experience: Students generated content based on the course topics, integrating their own examples and stories into the resources. Another theme was enhanced learning performance for low-achieving students: The model supported the learning process for low-achieving students with a significant improvement in their final results, but the model had no significant effect on high-achieving students. A final theme was maximised learning responsibilities for students: Students were required to understand the course content carefully, use external resources, and master the content-authoring software tools.

The course coordinators raised three key areas of improved educational practice. First, the teaching team felt more engaged in the course because they actively gave feedback and communicated with students via tutorials and email. Second, generating OER helped coordinators with curriculum development by adopting the OER development model as part of the learning curriculum. This included the increased use of technological tools to enhance the learning resources and harnessing support resources to facilitate student progress. A third area was adopting the OER development model for future semesters: The aggregation of learning resources in one place was essential for the accessibility and reusability of the content by future course coordinators and students.

Figure 1 shows the final OER development model after five iterations of use. At the centre of the figure are the three key stages. 'Building content' involves students creating OER through: collaborative learning or project-based learning so that students have a purpose for the activity; content-authoring tools with sufficient support to help students create their resource; incentives so that students feel value in the activity and motivation to complete it; and cognitive surplus or ideas for sharing so that the resource can be retained and reused by others. In the next stage, academics are involved in 'evaluating student-generated resources': technical evaluation to ensure that details of the OER are accurate and high quality; pedagogical evaluation to confirm that the OER align with teaching and learning goals and objectives; and evaluation of openness to ensure the integrity of the OER for others to retain, reuse, revise, remix, and/or redistribute. A dotted line shows that this stage may optionally involve student peer review as part of the evaluation process, but the academic role is essential. From the evaluation stage, the student-generated resources may undergo further refinement through the building stage and be re-evaluated. The stage after evaluation is necessary to turn the student-generated resource into OER, and this is the 'publishing resources' stage, which involves hosting the resources on an accessible platform and licencing the resources with appropriate licences to promote sharing. Student resources may be refined again at this stage to meet the requirements for open hosting and licencing. Completing these three stages leads to student-generated OER that can be created within the confines of a university course assignment.

The model is underpinned by five specific principles of social constructivism, which informed its integration into courses:

1. Learners are engaged in active learning activities [39];
2. Knowledge is constructed based on what learners understand rather than being teacher-driven [39];
3. Learning takes place in a real-world setting [42];
4. The evaluation must be carried out as part of the task to ensure the quality of the resources [39,42];
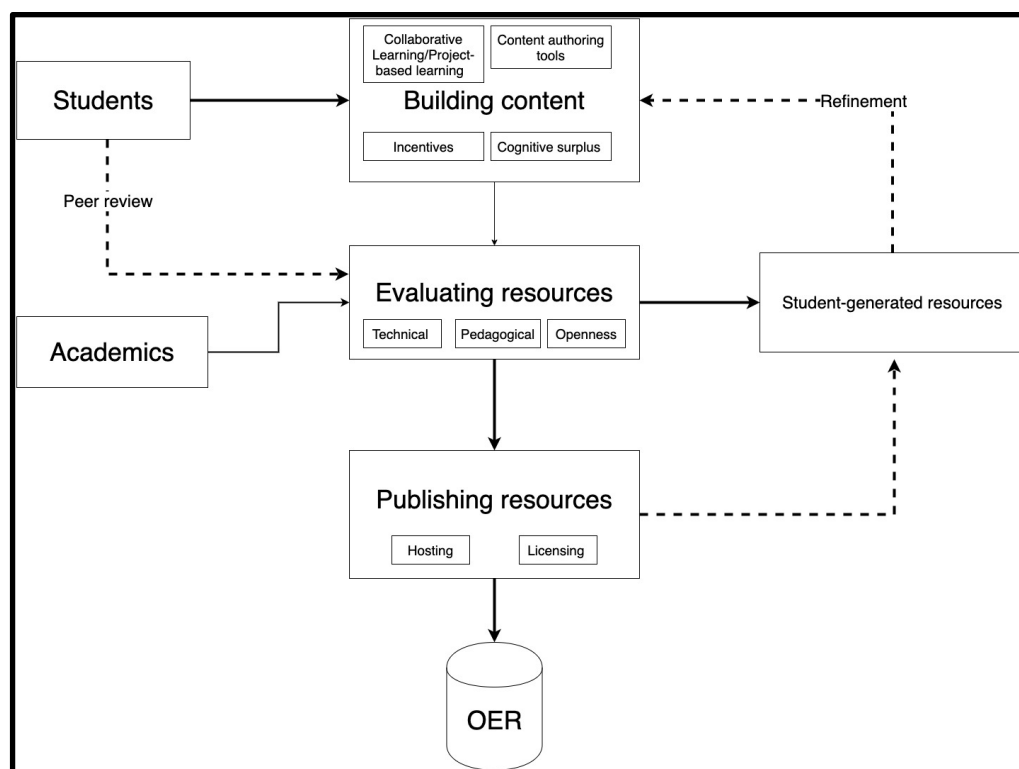5. The teacher's role is to engage with students and facilitate the learning process [37].

Figure 1. The OER development model [52].

3.2. Case Study 2

Case study 2 used the OER development model from Figure 1, but it extended the evaluation and audience of the OER to include professionals outside the university, as depicted in Figure 2. In-service educators were invited to provide input into the types of OER that students (pre-service educators) could create, and once the OER were published, the OER were shared back with the in-service educators for their feedback. Expanding the model to include professionals in the evaluation stage can contribute to quality assurance. Professionals may bring technical expertise beyond that possessed by academics, thus broadening the range of OER content that students may create and ensuring the OER's currency to practice. Professionals will also view OER differently from academics, so they may offer an alternative and possibly more authentic end-user perspective if the OER are intended for a professional audience. Involving professionals also helps align university courses to professional practice so that students feel assured that what they are learning is up-to-date. Involving professionals also comes with challenges such as the co-ordination of activities, managing expectations, and appropriate compensation for their time, but these are issues that most academics working in professional fields are familiar with, so they are easily overcome. In Figure 2, the arrow from the resulting OER to professionals represents the sharing of OER with in-service professionals, as occurred in Case study 2.

Over two cycles using the model, 55 students were invited to publish their resources openly, and 58.2% (*n* = 32) took up the invitation, a higher percentage than Case study 1, where 36% of students openly shared their work. Similar to Case study 1, student reflections highlighted that in-depth knowledge of content-authoring software tools was required. Students were to create digital newsletters in Word, but some used technologies such as Canva and Microsoft Publisher for their resources, which required reformatting for the open publishing tool Pressbooks. Student reflections and questions about the task confirmed that technical scaffolding is necessary for the OER model.
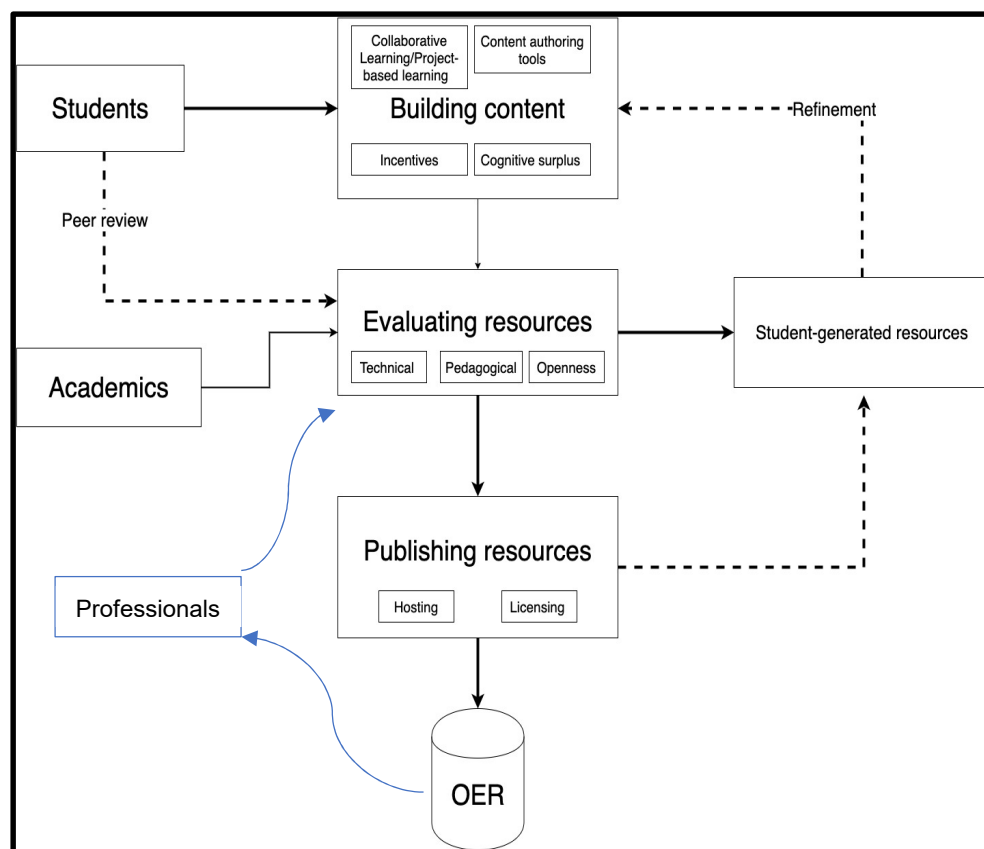
Figure 2. Adapted OER development model.

Analysis of the data collected from students revealed three key themes related to the benefits of the activity for students' learning experiences. First, students reported increased confidence, and a student stated, for example, 'I am so happy with my chapter. I am feeling proud I could do something like this'. Second, students found the activity personally meaningful. As in Case study 1, students also appreciated that they could personalise their resources and follow lines of inquiry that interested them. They reflected upon contacting local community organisations, conducting in-depth internet research, and connecting with a range of sources they had previously been unaware of. Third, the OER task contributed to students' self-efficacy with learning, as explained by one student, 'Throughout constructing the resources. I identified some areas that I was unsure about and felt that my knowledge grew in these areas with the research that was undertaken'.

The final grades of students who published are summarised in Table 2, which shows that open publication appealed to students of all academic levels, including low and mid-achieving students, where between 50% and 72.7% of students openly published. The small cohort numbers, however, provided inconclusive evidence about whether student-generated OER enhanced students' learning performance.

In terms of educational practice, the areas identified in Case study 1 were confirmed. First, staff were fully engaged during the course with navigating the OER task alongside students, and this engagement continued until resources were published 4–6 months later. Second, curriculum development was strengthened by integrating OER knowledge into initial teacher education and by the course coordinator's upskilling with content-authoring technologies to assist students and manage the open publishing platform. Third, the OER development model was adopted successfully, and the students' openly published resources became course resources for future cohorts. A further area of improved educational practice identified in this project was that the OER task promoted inclusion and encouraged diverse student perspectives to be openly shared and published.

Table 2. Final grades of students who published openly.

Final Grade	Number of Students Who Published Openly			
	Cycle 1	Cycle 2	Students Who Were Invited to Publish	Students Who Openly Published
50–54.5%	1	1	4	2 (50%)
55–64.5%	6	2	11	8 (72.7%)
65–74.5%	3	7	19	10 (52.6%)
75–84.5%	4	5	17	9 (52.9%)
85–100%	3	0	4	3 (75%)
TOTAL	17	15	55	32 (58.2%)

4. Discussion

University students usually spend hours solving problems and completing projects as part of their assessment requirements, so we explored the value that can be derived from sharing these efforts as OER. Our projects focussed on utilising student content generated through project-based learning approaches and renewable assessments that create learning resources shared openly. Case study 1 confirmed the design principles and pedagogical process of an OER development model at one university, across three disciplines, and over five cycles, and the model was successfully adapted in Case study 2 at another university, in another discipline, and over two cycles. The fact that the case study projects occurred seven years apart suggests that the model has durability. Equally important, the model is transposable and flexible enough for use within practical and theoretical courses and across a range of disciplines.

The evaluation stage, in particular, may provide particular benefits for open education as non-university stakeholders may become part of the process, helping to address 'the pervasive perception that, because they are free, OER are necessarily of inferior quality' [53] (p. 785). In higher education, academics evaluate resources and peer-review student resources as part of the assessment process, but for open publication, other stakeholders can be involved in this process, including in-service professionals (as in Case study 2), community experts, and users who will view or are represented by the resources. This aligns with studies that recommended working beyond the confines of academia to explore the wider potential of OEP [33,34]. Mechanisms for enhancing resource quality may also be built into the process at other levels, for example, through students' peer review and increased student involvement in the actual publication process, beyond choosing open licenses [17] and preparing artefacts. Additionally, evaluation criteria should not only assess the technological and pedagogical aspects of student-generated OER content but also the openness aspect that ensures the searchability and currency of the content, which is often presumed when an open license is associated with a resource.

By increasing student involvement in course assessment, student-generated OER promoted students' agency and active learning. Aligning with social constructivist theories of teaching and learning [18,44,45], students' discipline understandings were deepened through negotiating knowledge with and for others. As Shirky [14] observed, humans possess an ancient disposition to consume, but they also possess intrinsic motivations to create and share, acts that modern technology allows us to curate and disseminate en masse. In our case study, the OER students produced were aimed at an audience of their peers and in-service professionals, so students were driven to produce resources of quality and utility. This behaviour accords with research (i.e., [34,54]) which found that students are more inclined to share their work when they believe it will create benefits, and it affirms the value of demand-led models of OER recommended by Nikoi et al. [32]. Going beyond the consumption of knowledge, students became knowledge producers, taking responsibility for their learning activities [13,24,33], learning about academic integrity, and using course resources, including the course coordinators and teaching academics, to support their learning interests. In addition to providing the personalised learning experience online students commonly seek [25,30], our students bore increased responsibility for their own

learning, as they had to navigate the course content and support resources and learn the appropriate technology for producing their artefact. Through the act of creating something that would teach others, the students in our projects learned.

Students across both case study projects also exhibited more engagement with generating OER even when they did not choose to publish openly, presumably because they were learning through an authentic task. Our students were studying to become engineers, mathematicians, computer scientists, teachers, and professionals who source, use, and create resources, so learning these skills in a university course helped promote specific professional needs. We would argue that the process also catalysed innovation and creativity by prompting students to gain new technological skills and working methods. This included shifting perceptions of 'openness' through workshops and supporting resources. Students also became more aware of the benefits of OER after creating their resources, which was particularly relevant to the pre-service teachers in Case study 2, following UNESCO's recommendation that OER knowledge be integrated into initial teacher education [55]. Student-generated OER promotes transparency and attribution so that students can use their resources for future employment as evidence of professional knowledge-sharing or simply as an achievement they can take pride in.

In addition, the activity engaged low and mid-achieving students, perhaps because of its relevance to students' personalised, professional needs. Improved student confidence was reported across all courses involved in the two case study projects, indicating that the OER development model helped students better understand their discipline and, importantly, their place in it. High-achieving students may already possess skills for taking responsibility for their learning, and they are also usually quite confident in producing and sharing knowledge due to previous personal and professional experiences. Low and mid-achieving students, however, may still be developing such skills, so the OER development model offered a process whereby students could be supported more closely in developing these aspects of their professional identities. Relatedly, an essential element of the OER development process was to offer a range of choices within the OER development task to cater to students' diversity of experiences and interests. For example, in Case study 2, students were given eight prompts for each of the two resources to respond to, a range of choices that enhanced the personalised learning experience and provided variety in the resources produced. This approach was inclusive, valuing the knowledge students brought to higher education and giving voice to perspectives that may otherwise have gone unheard.

Central to student-generated OER is the course facilitator. Across both projects, enhancements to educational practice were evident as course facilitators played an active role in mediating knowledge. This included the collection of openly published resources in centralised sites so that future students and a wider audience could access and reuse the resources. The course facilitator's role as the more knowledgeable other [45], scaffolding students in creating and sharing artefacts, made the process of learning socially meaningful so that students could draw upon their own ideas and be supported to bring these ideas to fruition. By bringing course coordinators and students into dialogue, the OER development model prompted course coordinators to engage more deeply with their curriculum and course content to support students, further illustrating the notion of learning by teaching that is inherent when knowledge is shared.

Theoretically and pedagogically, the OER development model demonstrates a way of using cognitive surplus that firmly aligns with social constructivist ideas of teaching and learning. Each stage of the model shows how knowledge can be constructed cognitively and socially [37,39,42], from building and evaluating OER to openly publishing it. The model helps university students develop and expand their knowledge and perspectives through social sharing and negotiation and participate in authentic and meaningful university assessment tasks [19,26]. Technology has not only made it possible for cognitive surplus to be shared more widely than ever before [14], but within the OER model, it also provides opportunities for students to teach and learn from each other and to teach and learn from

experts and professionals beyond the university. Whether the OER students create are used for future teaching and learning as course resources or have a much wider application to real-world professions, student efforts for university assignments can potentially impact and inspire a range of OER users.

Despite the many benefits observed in our study, there are several challenges that may need to be addressed before student-generated OER can be used more widely in higher education. One issue relates to the sustainability of the task. Both projects described in this paper were supported by the universities where they occurred; Case study 1 was part of the first author's doctoral research, while Case study 2 was funded by a university grant and supported with the guidance of open education experts. Ongoing technological support was also necessary in both projects. Creating OER required all participants to upskill to understand content-authoring tools, open licences, and the benefits of creating and adopting OER. Moreover, course coordinators had to abandon the presumption that students were digital natives [52] and provide adequate technological scaffolds to support students. This involved weaving scaffolds into the assessment design to equip students with the skills of using content-authoring tools and raising awareness of the value of openness for lifelong learning. In practical terms, the OER development process may prove difficult to use with every course iteration (sometimes three times a year), demanding time and effort from students and course coordinators beyond the course duration and requiring extra support from learning designers, librarians, and technology specialists.

Other challenges to the process are more systemic. The model's success depends on academics willing to embed the process of student-generated OER within their courses, as the task requires a variation of assessment so that students can receive course credit for some or all aspects of the task. Much will depend on the flexibility for variation within the course or programme and the university's open educational policy and practice environment. As Evans et al. [56] pointed out, OEP are likely to be implemented and sustained 'where practice communities are actively created rather than simply assumed to exist, somehow preformed, as if ready and able to simply "implement" policies' (p. 102). Some institutions have comprehensive approaches to open educational practices, while others, such as most universities here in Australia, approach open education in a more ad hoc manner [57], leading to wavering developments in OEP. A clear open educational policy may reduce the costs of implementing student-generated OER as support may be drawn from faculty learning and teaching teams, librarians, and other central support units. Addressing systemic challenges would open up more possibilities for academics to explore open educational practices and experiment with practices such as student-generated OER in the future.

5. Conclusions

Over recent years, open educational resources have become essential for online education, particularly as a response to COVID-19-related school and university closures and social restrictions. However, while the use of OER significantly increases, more can be done to increase its production. There are many examples in the academic literature about utilising open pedagogy and tapping into student-generated content, yet there is a lack of published academic literature about learning design principles validated by research that can guide open practitioners. This article presented descriptive case studies that demonstrated the value of an OER development model for student learning and educational practice in courses across various disciplines, in both theoretical and practical subjects, and at different levels of study. From our experiences in several cycles of creating OER with students, we found that student-generated OER promoted digital upskilling and transferable knowledge, which may enhance student employability. The activity further boosted students' confidence, enhanced their learning experience, and increased their self-efficacy with learning. Creating OER with students also positively impacted educational practice through deeper staff engagement with courses, enhanced curriculum development, and increased digital upskilling and OER adoption. To balance the benefits we observed, our

discussion highlighted the challenges that academics may face when developing OER with students. A key contribution of the current study is providing a model for OER development with learning design principles that have been validated through an iterative research approach comprising five cycles of design-based research and two cycles of action research.

A limitation of the study is the relatively small scale of the projects involving less than 160 participants. Both were pilot projects seeking 'proof of concept' in the universities where they were conducted and as these have been successful, it is envisaged that future projects will be much broader in scale. Another limitation is that the OER development model has only been tested across the two sites in this study. This limitation can be addressed with future multi-site projects conducted within the same period.

Upon reflection, we expect that the OER development model presented in this study will continue to evolve, as all models do. However, we contend that the learning design principles and key stages of the model will remain largely unchanged as each builds upon previous studies about student-generated resources and OER, and they have remained constant across the seven research cycles presented here. Following the pragmatic research approaches of DBR and action research, any improvements to the model will arise from its application to different groups of students in different fields, producing a range of OER.

Further research is recommended into the value and sustainability of student-generated OER in universities outside Australia and in disciplines other than those mentioned in this article. These explorations might lead to further refinements and model variations to account for contextual needs and constraints. Another research avenue could explore the institutional policies, processes, and programmes that promote or inhibit teaching academics' open educational practices in higher education. People will gravitate towards the opportunities they are presented with [14]. So, if the systemic and other challenges outlined in this article can be overcome and academics are supported to innovate with open educational practices, we are confident many will rise to the challenge.

References

1. Fatayer, M. Engagement of Digital Natives in the Development of Learning Content for Open Educational Resources. TARC International Conference on Learning and Teaching 2013: Innovation and Transformation in Learning and Teaching, Kuala Lumpur, Malaysia. Available online: https://www.researchgate.net/profile/Mais-Fatayer/publication/259451730_Engagement_of_Digital_Natives_in_the_development_of_learning_content_for_Open_Educational_Resources/links/00b4952bad28a6a12e000000/Engagement-of-Digital-Natives-in-the-development-of-learning-content-for-Open-Educational-Resources.pdf (accessed on 15 September 2023).
2. Wiley, D.; Hilton, J. Defining OER-enabled pedagogy. *Int. Rev. Res. Open Distrib. Learn.* **2018**, *19*, 133–147. [CrossRef]
3. Zaid, Y.A.; Alabi, A.O. Sustaining Open Educational Resources (OER) initiatives in Nigerian Universities. *Open Learn. J. Open Distance E-Learn.* **2021**, *36*, 181–197. [CrossRef]

4. Coughlan, T.; Pitt, R.; Farrow, R. Forms of innovation inspired by open educational resources: A post-project analysis. *Open Learn. J. Open Distance E-Learn.* **2019**, *34*, 156–175. [CrossRef]

5. Diallo, B.; Thuo, C.W.; Wright, C.R. Approaches to the production and use of OERs: The African virtual university experience. In *Open Educational Resources: Innovation, Research and Practice*; McGreal, R., Kinuthia, W., Marshall, S., Eds.; Commonwealth of Learning: Vancouver, BC, Canada, 2013; pp. 91–103.

6. Miao, F.; Mishra, S.; McGreal, R. *Open Educational Resources: Policy, Costs, Transformation*; UNESCO: Paris, France, 2016. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000244365 (accessed on 22 April 2019).

7. Panda, S.; Santosh, S. Faculty perception of openness and attitude to open sharing at the Indian National Open University. *Int. Rev. Res. Open Distrib. Learn.* **2017**, *18*, 1–23. [CrossRef]

8. McNally, M.B.; Christiansen, E.G. Open enough? Eight factors to consider when transitioning from closed to open resources and courses: A conceptual framework. *First Monday* **2019**, *24*, 1–16. [CrossRef]

9. Bossu, C.; Bull, D.; Brown, M. Opening up Down Under: The role of open educational resources in promoting social inclusion in Australia. *Distance Educ.* **2012**, *33*, 151–164. [CrossRef]

10. Stagg, A.; Nguyen, L.; Bossu, C.; Partridge, H.; Funk, J.; Judith, K. Open educational practices in Australia: A first-phase national audit of higher education. *Int. Rev. Res. Open Dis.* **2018**, *19*, 173. [CrossRef]

11. Sener, J. In search of student-generated content in online education. *E-Mentor* **2007**, *4*, 21.

12. Pérez-Mateo, M.; Maina, M.F.; Guitert, M.; Romero, M. Learner generated content: Quality criteria in online collaborative learning. *Eur. J. Open Distance E-Learn.* **2011**, *14*, 1–12. Available online: http://openaccess.uoc.edu/webapps/o2/bitstream/10609/124786/1/Perez_EURODL_Learner.pdf (accessed on 11 February 2023).

13. Neary, M. Student as producer: A pedagogy for the avant-garde? *Learn. Exch.* **2010**, *1*, 1–12. Available online: http://eprints.lincoln.ac.uk/id/eprint/4186/1/15-72-1-pb-1.pdf (accessed on 20 February 2022).

14. Shirky, C. *Cognitive Surplus: Creativity and Generosity in a Connected Age*; Penguin Press: London, UK, 2010.

15. Seraphin, S.B.; Grizzell, J.A.; Kerr-German, A.; Perkins, M.A.; Grzanka, P.R.; Hardin, E.E. A conceptual framework for non-disposable assignments: Inspiring implementation, innovation, and research. *Psychol. Learn. Teach.* **2019**, *18*, 84–97. [CrossRef]

16. OPAL. Beyond OER: Shifting Focus to Open Educational Practices—OPAL Report 2011. 2011. Available online: https://www.oerknowledgecloud.org/archive/OPAL2011.pdf (accessed on 5 December 2016).

17. Tietjen, P.; Asino, T.I. What is open pedagogy? Identifying commonalities. *Int. Rev. Res. Open Distrib. Learn.* **2021**, *22*, 185–204. [CrossRef]

18. Paskevicius, M.; Irvine, V. Open education and learning design: Open pedagogy in praxis. *J. Interact. Media Educ.* **2019**, *1*, 1–10. [CrossRef]

19. Bali, M.; Cronin, C.; Jhangiani, R.S. Framing Open Educational Practices from a social justice perspective. *J. Interact. Media Educ.* **2020**, *1*, 1–12. [CrossRef]

20. Mays, E.; DeRosa, R.; Jhangiani, R.; Robbins, T.; Squires, D.; Ward, J.; Andrzejewski, A.; Burns, S.; Moore, M. *A Guide to Making Open Textbooks with Students*; Rebus Community: Montreal, QC, Canada, 2017; Available online: https://openlibrary-repo.ecampusontario.ca/jspui/handle/123456789/334 (accessed on 15 September 2023).

21. Paviotti, G.; D'Angelo, I.; Giaconi, C.; Cavicchi, A. Open pedagogy practices: A case study in undergraduate education. *J. E-Learn. Knowl. Soc.* **2020**, *16*, 1–10.

22. Paskevicius, M.; Irvine, V. Practicalities of implementing open pedagogy in higher education. *Smart Learn. Environ.* **2019**, *6*, 23. [CrossRef]

23. Hardy, J.; Bates, S.P.; Casey, M.M.; Galloway, K.W.; Galloway, R.K.; Kay, A.E.; Kirsop, P.; McQueen, H.A. Student-generated content: Enhancing learning through sharing multiple-choice questions. *Int. J. Sci. Educ.* **2014**, *36*, 2180–2194. [CrossRef]

24. Lazzara, J.; Clinton-Lisell, V. Using social annotation to enhance student engagement in psychology courses. *Scholarsh. Teach. Learn. Psychol.* **2022**. *ahead of print*. [CrossRef]

25. Miceli, H. Non-Majors Science Students as Content Creators—Open Pedagogy Notebook. 2020. Available online: https://openpedagogy.org/course-level/non-majors-science-students-as-content-creators/ (accessed on 25 September 2023).

26. Kruger, J.S.; Hollister, C. Engaging undergraduate public health students through a textbook creation project. *Pedagog. Health Promot.* **2020**, *7*, 226–234. [CrossRef]

27. Abas, S. Critical multimodal literacy practices in student-created comics. *Literacy* **2023**, *57*, 161–170. [CrossRef]

28. Snelson, C. Video production in content-area pedagogy: A scoping study of the research literature. *Learn. Media Technol.* **2018**, *43*, 294–306. [CrossRef]

29. Huang, W.H.D.; Hood, D.W.; Yoo, S.J. Gender divide and acceptance of collaborative Web 2.0 applications for learning in higher education. *Internet High. Educ.* **2013**, *16*, 57–65. [CrossRef]

30. Lee, K. Openness and innovation in online higher education: A historical review of the two discourses. *Open Learn. J. Open Distance e-Learn.* **2021**, *36*, 112–132. [CrossRef]

31. Koehler, M.; Mishra, P. What is technological pedagogical content knowledge (TPACK)? *Contemp. Issues Technol. Teach. Educ.* **2009**, *9*, 60–70. [CrossRef]

32. Nikoi, S.K.; Rowlett, T.; Armellini, A.; Witthaus, G. CORRE: A framework for evaluating and transforming teaching materials into open educational resources. *Open Learn. J. Open Distance e-Learn.* **2011**, *26*, 191–207. [CrossRef]

33. Nizami, U.; Shambaugh, A. Open pedagogy through community-directed, student-led partnerships: Establishing CURE (Community-University Research Exchange) at Temple University Libraries. *Open Prax.* **2019**, *11*, 443–450. [CrossRef]

34. Williams, C. Student perceptions of open pedagogy and community-engaged service learning. In *Active Learning—Research and Practice for STEAM and Social Sciences Education*; Ortega-Sánchez, D., Ed.; IntechOpen: London, UK, 2022. [CrossRef]

35. Luo, T.; Hostetler, K.; Freeman, C.; Stefaniak, J. The power of open: Benefits, barriers, and strategies for integration of open educational resources. *Open Learn. J. Open Distance e-Learn.* **2020**, *35*, 140–158. [CrossRef]

36. Clinton-Lisell, V. Open pedagogy: A systematic review of empirical findings. *J. Learn. Dev.* **2021**, *8*, 255–268. Available online: https://files.eric.ed.gov/fulltext/EJ1314199.pdf (accessed on 15 September 2023). [CrossRef]

37. Von Glasersfeld, E. Learning as a constructive activity. Problems of representation in the teaching and learning of mathematics. In Proceedings of the 5th Annual Meeting of the North American Group of Psychology in Mathematics Education, Montreal, QC, Canada, 19–25 July 1987; pp. 41–101.

38. Al-Huneidi, A.; Schreurs, J. Constructivism based blended learning in higher education. *Int. J. Emerg. Technol. Learn.* **2013**, *7*, 4–9. Available online: https://www.learntechlib.org/p/44884/ (accessed on 15 September 2023). [CrossRef]

39. Ally, M. Foundations of educational theory for online learning. In *The Theory and Practice of Online Learning*; Anderson, T., Ed.; Athabasca University Press: Athabasca, AB, Canada, 2008; pp. 15–44.

40. Grabowski, B. ICT as an enabler for effective learning design: Its evolving promise. *Int. J. Educ. Media Technol.* **2009**, *3*, 12–23.

41. Wang, F.; Hannafin, M.J. Design-based research and technology-enhanced learning environments. *Educ. Technol. Res. Dev.* **2005**, *53*, 5–23. [CrossRef]

42. Applefield, J.M.; Huber, R.; Moallem, M. Constructivism in theory and practice: Toward a better understanding. *High Sch. J.* **2001**, *84*, 35–53.

43. Schunk, D.H. *Learning Theories: An Educational Perspective*, 8th ed.; Pearson: London, UK, 2020.

44. Cole, M.; Bruner, J.S. Cultural differences and inferences about psychological processes. *Am. Psychol.* **1971**, *26*, 867–876. [CrossRef]

45. Vygotsky, L.S. *Mind in Society: The Development of HIGHER Mental Processes*; Luria, A.R.; Lopez-Morillas, M.; Cole, M.; Wertsch, J.V., Translators; Harvard University Press: London, UK, 1978.

46. Miles, M.B.; Huberman, A.M.; Saldaña, J. *Qualitative Data Analysis: A Methods Sourcebook*, 3rd ed.; Sage: Thousand Oaks, CA, USA, 2014.

47. Denzin, N.K.; Lincoln, Y.S. (Eds.) *The SAGE Handbook of Qualitative Research*, 4th ed.; SAGE: Los Angeles, CA, USA, 2011.

48. Design-Based Research Collective. Design-Based Research: An emerging paradigm for educational inquiry. *Educ. Res.* **2003**, *32*, 5–8. [CrossRef]

49. Lewin, K. Action research and minority problems. *J. Soc. Issues* **1946**, *2*, 34–46. [CrossRef]

50. Tualaulelei, E.; Hawkins, K. (Eds.) *Gems and Nuggets: Multicultural Education for Young Children*; Pressbooks; Online; 2020. Available online: https://usq.pressbooks.pub/gemsandnuggets1/ (accessed on 4 October 2023).

51. Tualaulelei, E.; Macdonald, J. (Eds.) *Hidden Treasures: Intercultural Resources for Early Years Educators*; Pressbooks; Online; 2020. Available online: https://usq.pressbooks.pub/gemsandnuggets2/ (accessed on 4 October 2023).

52. Fatayer, M. *Towards a Sustainable Open Educational Resources Development Model: Tapping into the Cognitive Surplus of Student-Generated Content*; Western Sydney University: Sydney, Australia, 2016.

53. Wiley, D.; Bliss, T.; McEwen, M. Open educational resources: A review of the literature. In *Handbook of Research on Educational Communications and Technology*, 4th ed.; Spector, J.M., Merrill, M.D., Elen, J., Bishop, M.J., Eds.; Springer: Berlin/Heidelberg, Germany, 2014; pp. 781–789.

54. Tromp, G.W.; Long, P.D. Why do people share content? Identifying why students support sharing course material. *Open Learn. J. Open Distance E-Learn.* **2013**, *28*, 21–35. [CrossRef]

55. United Nations Educational, Scientific and Cultural Organization. *Recommendation on Open Educational Resources (OER)*; UNESCO: Paris, France, 2019.

56. Evans, J.; Jordan, S.; Wolfenden, F. Developing academics' assessment practices in open, distance and e-learning: An institutional change agenda. *Open Learn. J. Open, Distance E-Learn.* **2016**, *31*, 91–107. [CrossRef]

57. Bossu, C.; Stagg, A. The potential role of Open Educational Practice policy in transforming Australian higher education. *Open Prax.* **2018**, *10*, 145–157. Available online: https://www.learntechlib.org/p/183576/ (accessed on 18 April 2019). [CrossRef]