Reusable and Shareable Orchestration Packages

Nabeel Parker
University of Cape Town
Cape Town, South Africa
prknab003@myuct.ac.za

Morné Valentyn
University of Cape Town
Cape Town, South Africa
vlnmor001@myuct.ac.za

Hussein Suleman
University of Cape Town
Cape Town, South Africa
hussein@cs.uct.ac.za

Christoph Meinel
Hasso Plattner Institute
Potsdam, Germany
christoph.meinel@hpi.de

Lighton Phiri*
University of Cape Town
Cape Town, South Africa
lphiri@cs.uct.ac.za

ABSTRACT

Orchestration of learning, a process that involves the real-time management of learning activities, is known to be challenging. While the orchestration processes and resources used during orchestration of learning activities can be reused, sharing them is a non trivial task. We propose an end-to-end Reusable Virtual Orchestration Appliances (rVOA) workflow, based on organised orchestration of learning activities, for sharing and reusing these processes and resources as Open Education Resources (OERs). We show the feasibility of the rVOA workflow by implementing an offline authoring tool—used to create and playback the orchestration packages—and an online OER repository—used to store the packages and, additionally, to facilitate easy access. Studies conducted to assess the usability of the authoring tool and the repository yielded promising results, suggesting the potential usability of the workflow.

CCS CONCEPTS

• **Information systems** → **Digital libraries and archives**; • **Applied computing** → **Digital libraries and archives**; **Computer-assisted instruction**;

KEYWORDS

Authoring Tools, Orchestration, Open Education Resources, Packaging, Repositories

1 INTRODUCTION

Orchestration of learning activities involves process that educators perform in formal learning spaces in order to manage learning activities in real-time [4]. Orchestration of learning is known to be complex and challenging due its multi-faceted nature and, additionally, the multiple constraints associated with it. In addition these challenges, orchestration has been observed to be performed in an ad hoc manner [10]. Collectively, the orchestration challenges and constraints and, its ad hoc nature poses a risk of adversely affecting the effective orchestration of learning activities.

Orchestration can be viewed as comprising two core components: scripting and conducting. [12]. Scripting typically involves pre-session management tasks aimed at planning and addressing teaching objectives. Conducting, on the other hand, involves processes required during session management and necessary for adapting the educational setting. Although the teaching objectives, processes and resources used during the orchestration of learning activities can, in certain instances, be reused by other educators, the ad hoc nature of orchestration especially makes this difficult to achieve.

In our previous work [10], we proposed to streamline orchestration of learning activities by explicitly organising activities and, additionally, focusing on three orchestration aspects—activity management, resource management and sequencing—outlined below. We have also demonstrated the effectiveness of streamlined orchestration and, its potential positive impact on the user experience [9].

- *Activity Management.* This aspect is meant to enable the structuring of learning activities to be orchestrated during session management.
- *Resource Management.* This aspect allows educators to organise teaching and learning resources to be used during session management. Each resource is mapped and associated with activities defined during Activity Management.
- *Sequencing Activity.* This aspect enables educators to explicitly specify the order to be followed to orchestrate learning activities.

*Corresponding author

This paper presents an Reusable Virtual Orchestration Appliances (rVOA) workflow for facilitating the sharing, reusability and remixing of orchestration processes and resources using the concept of reusable orchestration packages. A reference implementation of the workflow, comprising of an offline authoring tool and an online repository, is also presented. The offline authoring tool is used to create, playback and package orchestration packages, while the online repository serves the purpose of storing and enabling easy access to the orchestration packages.

The work presented in this paper contributes the following:

1. Workflow for sharing reusable orchestration packages as Open Education Resources (OERs).
2. Reference implementation of the OER workflow, comprising of an offline authoring tool and an online repository.
3. Results from usability experiments conducted to evaluate the authoring tool and the repository.

The remainder of this paper is structured as follows. Section 2 presents background and related literature, discussing how OERs are currently implemented. In Section 3, the proposed OER workflow, and a reference implementation are described. Section 4 presents the findings of experiments conducted to evaluate the authoring tool and online repository. Finally, Section 5 presents general concluding remarks.

2 RELATED WORK

2.1 OER Repository platforms

A number of OER platforms have been set up to provide free and open educational content to educators and learners. Most of the platforms do not offer additional services beyond facilitating searching and browsing of content.

MIT OpenCourseWare (OCW)[1] is an OER platform that publishes organised curated high-quality educational course materials tertiary institutions [1]. While the principle audience of OCW are independent learners, educators were the initial target audience. A variety of services have thus been implemented that are specifically tailored for educators. OCW Educator helps educators easily search through the OCW library through a search and browse interface. OCW Educator also provides an Instructor Insights services where instructors share their teaching experience and approaches to teaching [5].

OER Commons[2] is a dynamic OER repository comprising of content for different education levels. OER Commons is designed to be a global network of OERs and is thus integrated with the Open Author service that allows for the creation of different authoring formats. Resource Builder is used for creating bundled resources consisting of different content types. Authors can also create content views using Lesson Builder and Module Builder. Lesson Builder is used to build interactive lesson and Module Builder interactive modules.

While some OER platforms have integrated authoring tools and services for interacting with OERs, most of these services are only aimed at creating and manipulating OERs. More importantly, the resources shared are typically basic documents and media files. **??** shows a summary of some popular OER platforms with corresponding content types available and authoring services available to educators. This chapter presents a workflow for sharing sequenced interactive bundled resources for use during orchestration of learning activities.

Repository software tools are specialised forms of information management systems which are used to manage Digital Libraries (DLs), organised collections of digital content that can easily be accessed by end users. Repository software tools are thus Digital Library Systems (DLSes), whose primary goals are to ensure the long-term preservation of digital objects, facilitate the management of the digital objects and enable effective and easy access to the digital object [3].

2.2 Institutional Repositories

2.2.1 Fundamental aspects. There are a number of elements that guarantee the effectiveness of repository software tools. Unique identifiers are used to identify digital objects when making reference to them. Metadata provides representational information necessary to understand digital objects, once stored in the repository. The metadata is either used to administer the digital objects (administrative metadata), to enable digital objects to be easily discovered (descriptive metadata) or to store provenance information (preservation metadata). Finally, interoperability and standards enable repository software tools to easily interact with external services. For instance, Open Archives Initiative Protocol for

[1] https://ocw.mit.edu

[2] https://www.oercommons.org

Metadata Harvesting (OAI-PMH) for metadata harvesting enables external services to automatically harvest repository metadata [7], while Sword protocol facilitates remote deposit of digital objects into repositories [2, 8].

2.2.2 Core repository features. Fundamentally, repositories software tools perform three core functions: facilitate access to repository objects, enable the management of the digital objects and finally, facilitate the long-term storage of the digital objects. The access to repository objects involves information discovery services such as searching and browsing. The management of objects is necessary in order to make changes to metadata entries, update digital objects and to delete digital objects. Finally, the storage of digital objects typically involves associating metadata with digital objects and properly organising the objects for future reference.

2.2.3 Open source repository tools. There currently exists a number of open source digital repository software tools that can be used to build and set up repositories, and they all share common characteristics of providing features and functionalities necessary to store, manage and enable access to digital objects. Some of the popular open source tools that are used as OER platforms include DSpace[3], EPrints[4] and Fedora Commons[5]. DSpace is a digital asset management system designed for long-term storage of scholarly research output [11]. EPrints is an online archival tool specifically tailored for document-style content. Fedora Commons is an architectural framework that provides a standards-based platform and services for the development of repository software tools.

2.2.4 Summary. Most repository tools provide services for interacting with repository objects. In addition, a number of them implement popular international standards that ensure interoperability with external services [6]. However, of the existing open source tools, Fedora Commons is explicitly designed to handle complex digital objects. In addition, it known to be scalable. Furthermore, it has a flexible architecture that allows for implementation of specialised front-end applications.

[3] http://www.dspace.org
[4] http://www.eprints.org
[5] http://fedora-commons.org

3 REUSABLE ORCHESTRATION PACKAGES

- System Usability Scale (SUS) details...
- Xxxxx

3.1 Reusable Orchestration OER Workflow

The rVOA workflow is designed to allow orchestration processes and resources to be shared and reused as OERs. Using three distinct stages: scripting, packaging and ingestion, orchestration processes and resources are shared as bundled orchestration packages.

3.1.1 Scripting.

3.1.2 Packaging.

3.1.3 Ingestion.

3.2 Reference Implementation

3.2.1 Offline Authoring Tool.

3.2.2 Online Repository.

4 EVALUATION

4.1 Authoring Tool Usability

Table 1: The three core features of the authoring tool—sequencing of resources, playback of sequenced resources and packaging—were independently assessed to assess their perceived usability.

Task	Description
Task 1	Upload of resources
Task 2	Sequence and download resources
Task 3	Sequence and save resources
Task 4	Preview sequenced resources
Task 5	Delete resources
Task 6	Package resources
Task 7	Share resources

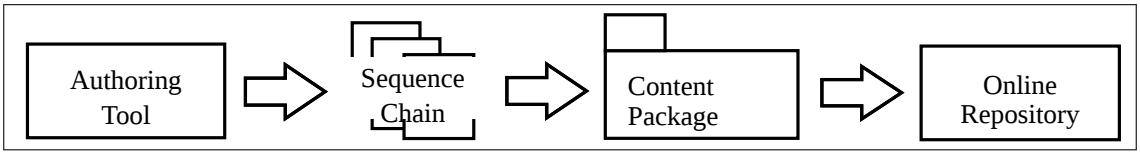

Figure 1: rVOA high-level workflow.

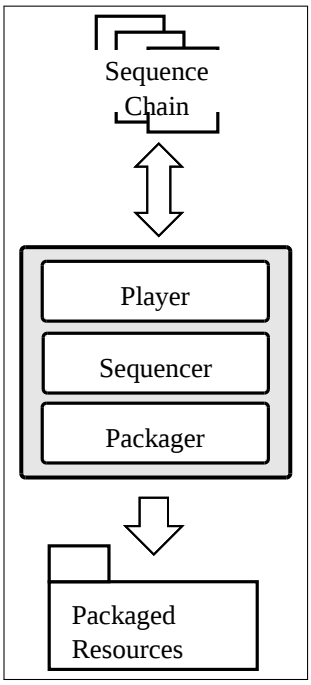

Figure 2: rVOA player.

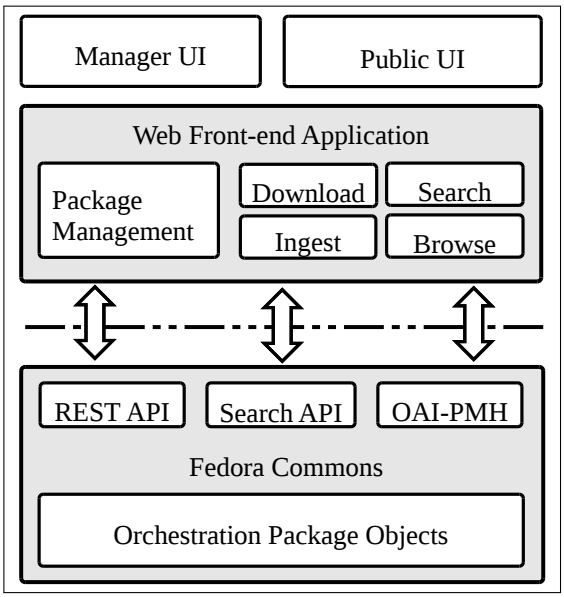

Figure 3: rVOA repository.

4.2 Repository Usability

Table 2: The usability of the repository front-end involved assessing package ingestion, discovery and downloading features. System login was assessed alongside ingestion of packages since this is only possible for registered users.

Task	Description
Task 1	Register for a new account
Task 2	Search and download a package
Task 3	Browse and download a package
Task 4	Login and ingest a package

Table 3: Package workload sizes for conducting performance experiments.

Workload	W1	W2	W3	W4	W5	W6
Packages	10	50	100	200	500	1000

4.3 Repository Performance

5 CONCLUSIONS AND FUTURE WORK

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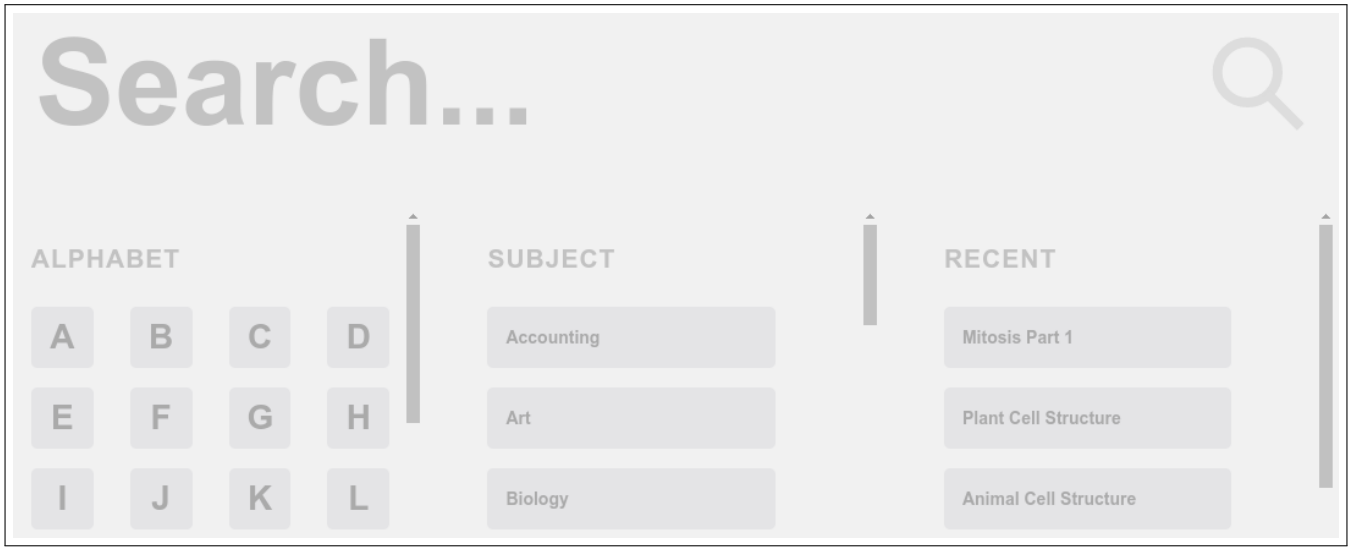

Figure 4: The front-end Web application provides information discovery services for searching and browsing curated orchestration packages in the repository.

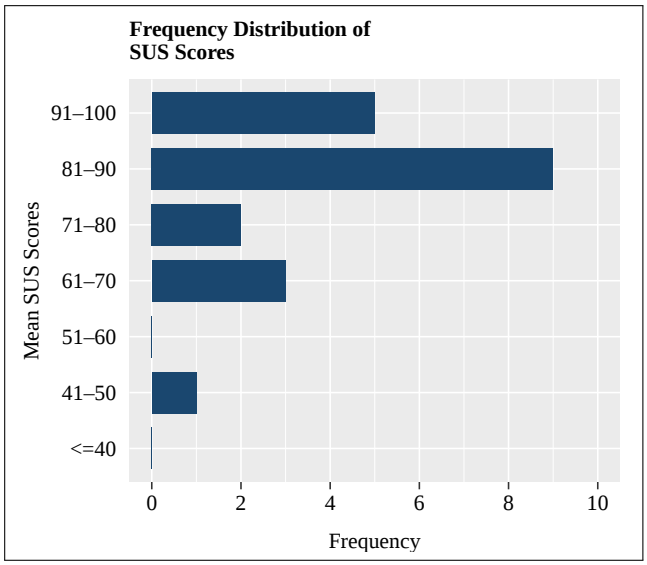

Figure 5: The frequency distribution of the mean SUS scores for the 20 participants, showing higher scores for the majority of the participants.

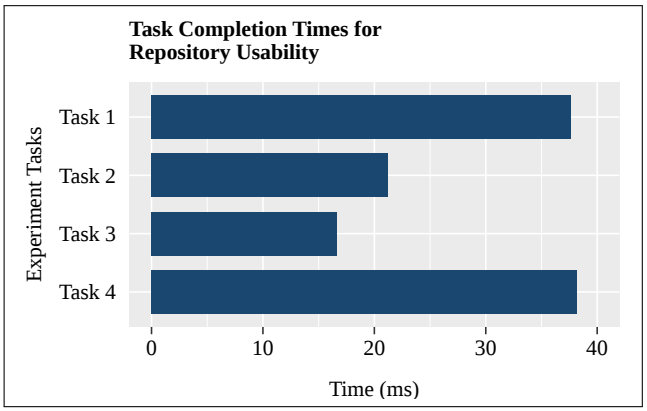

Figure 6: The mean tasks times during the repository usability study.

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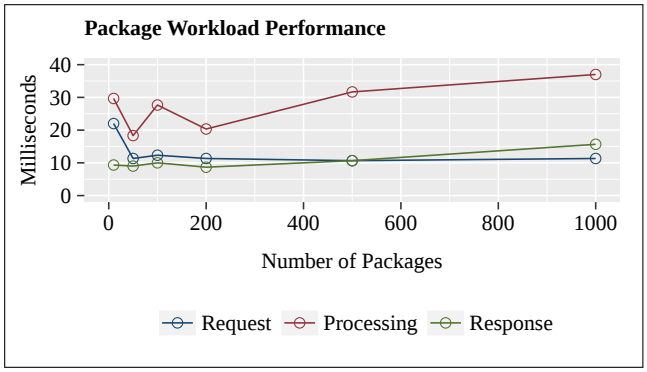

Figure 7: The repository performance results indicates linearly increasing times with increasing workloads

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