

**ACTIVE LEARNING STRATEGIES
IN HIGHER EDUCATION:
TEACHING FOR LEADERSHIP,
INNOVATION, AND CREATIVITY**

This page intentionally left blank

ACTIVE LEARNING STRATEGIES IN HIGHER EDUCATION: TEACHING FOR LEADERSHIP, INNOVATION, AND CREATIVITY

EDITED BY

ANASTASIA MISSEYANNI

Deree – The American College of Greece, Athens, Greece

MILTADIS D. LYTRAS

Deree – The American College of Greece, Athens, Greece

PARASKEVI PAPADOPOULOU

Deree – The American College of Greece, Athens, Greece

CHRISTINA MAROULI

Deree – The American College of Greece, Athens, Greece



United Kingdom – North America – Japan – India – Malaysia – China

Emerald Publishing Limited
Howard House, Wagon Lane, Bingley BD16 1WA, UK

First edition 2018

Copyright © 2018 Emerald Publishing Limited

Reprints and permissions service

Contact: permissions@emeraldinsight.com

No part of this book may be reproduced, stored in a retrieval system, transmitted in any form or by any means electronic, mechanical, photocopying, recording or otherwise without either the prior written permission of the publisher or a licence permitting restricted copying issued in the UK by The Copyright Licensing Agency and in the USA by The Copyright Clearance Center. Any opinions expressed in the chapters are those of the authors. Whilst Emerald makes every effort to ensure the quality and accuracy of its content, Emerald makes no representation implied or otherwise, as to the chapters' suitability and application and disclaims any warranties, express or implied, to their use.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

ISBN: 978-1-78714-488-0 (Print)

ISBN: 978-1-78714-487-3 (Online)

ISBN: 978-1-78714-944-1 (Epub)



ISOQAR certified
Management System,
awarded to Emerald
for adherence to
Environmental
standard
ISO 14001:2004.

Certificate Number 1985
ISO 14001



INVESTOR IN PEOPLE

Contents

About the Authors	ix
Preface	xvii
Acknowledgments	xxi

Introduction

<i>Anastasia Misseyanni, Miltiadis D. Lytras, Paraskevi Papadopoulou and Christina Marouli</i>	1
--	---

SECTION I: ACTIVE LEARNING IN HIGHER EDUCATION: A THEORETICAL BACKGROUND

Chapter 1 Toward an Epistemology of Active Learning in Higher Education and Its Promise	
<i>Lorayne Robertson</i>	17
Chapter 2 Designing for Active Learning: A Problem-Centered Approach	
<i>Susan Stetson-Tiligadas</i>	45

SECTION II: ACTIVE LEARNING STRATEGIES IN HIGHER EDUCATION: “STORIES” AND LESSONS LEARNT

Chapter 3 Active Learning Stories in Higher Education: Lessons Learned and Good Practices in STEM Education	
<i>Anastasia Misseyanni, Paraskevi Papadopoulou, Christina Marouli and Miltiadis D. Lytras</i>	75
Chapter 4 Concepts and Communication in the Early Stages of an Environmental Science Degree: A Case Study of Formative Activities and Tasks	
<i>Peter J. Shaw</i>	107

Chapter 5 Active Learning Strategies: Stories and Lessons Learnt – Studying Environment in the Field <i>Daniel Moscovici and Emma Witt</i>	133
Chapter 6 Online Learning as the Catalyst for More Deliberate Pedagogies: A Canadian University Experience <i>Lorayne Robertson, Wendy Barber and William Muirhead</i>	151
Chapter 7 Active, Cooperative Learning in Online Higher Education. The Learning Design for “Change Management” at the Universitat Oberta de Catalunya <i>Eva Rimbau-Gilabert</i>	169
Chapter 8 Engaging the Nonart History Student: A Tale of Five Football Players (and Others) in Roman Art <i>Gretchen Krehling McKay</i>	187
Chapter 9 Preservice Teachers and Active Learning in Technology-Enhanced Learning: The Case of the University of West Bohemia in the Czech Republic <i>Zbyněk Filipi and Lucie Rohlíková</i>	211
Chapter 10 Intercultural Talent Management Model and its Application as an Active Teaching and Learning Strategy. Preservice Teachers in a New Time and Space Dimension: Virtuality <i>Eileen Sepúlveda-Valenzuela, Marcelo Careaga Butter and María Graciela Badilla-Quintana</i>	247
Chapter 11 Active Learning in Practice: Techniques and Experiences in Information Systems Courses in Brazil <i>Ronney Moreira de Castro, Sean W. M. Siqueira, César Augusto R. Bastos and Maria Cristina Pfeiffer Fernandes</i>	273
Chapter 12 Using Socrative App for Accounting Students in Higher Education <i>Inés González-González, Cristina Alcaide-Muñoz and Ana Isabel Jimenez-Zarco</i>	293

Chapter 13 Enhancing Learner Autonomy and Active Learning Using Digital Portfolio	
<i>Linda Pospisilova</i>	315

SECTION III: A VISION FOR HUMANITY THROUGH HIGHER EDUCATION

Chapter 14 The Pedagogical Legacy of Dorothy Lee and Paulo Freire	
<i>Azril Bacal Roij</i>	339

Chapter 15 A New Vision for Higher Education: Lessons from Education for the Environment and Sustainability	
<i>Christina Marouli, Anastasia Misseyanni, Paraskevi Papadopoulou and Miltiadis D. Lytras</i>	361

Index	389
-------	-----

This page intentionally left blank

About the Authors

Cristina Alcaide-Muñoz is a PhD Student in the Business Administration Department at the Public University of Navarre, Spain. She holds a research grant in the Department of Business Administration (Public University of Navarre) to develop the line of research based on operations management, focusing on high-performance manufacturing organizations. Her research encompasses operations management, particularly, quality management and strategic planning. Moreover, she teaches operations management and human resources management at the Public University of Navarre.

César Augusto R. Bastos is a PhD Student in Information Systems at the Federal University of the State of Rio de Janeiro (UNIRIO), Brazil. He has experience in education, focusing on educational technology, and more specifically on the following subjects: Teaching-Using computers, Robotics, and Physics. He attained his Bachelor in Licenciatura em Física from the Universidade Federal do Rio de Janeiro (1988) and Master in Computer Science from the Universidade Federal do Rio de Janeiro (2005), Brazil.

Azril Bacal Roij has a long higher educational career in Perú, México, Sweden, and Spain. He was Humanities Endowment Scholar at Otterbein College (1995), and Visiting Lecturer at UCLA (1996). He is currently affiliated with the Sociology Department, taught a course on Dorothy Lee at the Anthropology Department, Uppsala University. He teaches peace education/culture of peace at “Centro Internacional de Prospectiva y Altos Estudios” (CIPAE), Puebla, México. He held academic administrative posts in Perú and México. His work covers various fields, and he has authored books, chapters, and journal articles on: ethnicity, citizenship, national identity, higher education, peace education, rural development, and intercultural dialogue.

María Graciela Badilla-Quintana is Assistant Professor and Associate Researcher at CIEDE-UCSC, Universidad Católica de la Santísima Concepción, Chile. She is a Journalist, Licentiate in Social Communication, Teacher of Primary Education, Master in Education, and PhD in Pedagogical Investigation. Currently, she is Director of the Doctoral in Education program, and Editor-in-Chief of the *REXE Journal*.

Her research focuses on ICT integration on Educational Innovation and includes immersive virtual worlds and gamification. Between 2016 and 2018 she is Visiting Researcher (postdoc) in the Laboratory for Embodied Cognition and Embodied Games at Arizona State University, USA thanks to Becas Chile scholarship.

Wendy Barber holds a BPHE, BEd, Med, and a PhD from the University of Toronto. She is Assistant Professor in the Faculty of Education at the University of Ontario Institute of Technology in Oshawa, Canada and has also been a program director in that faculty. Her research interests are: Health and Physical Education, wearable technologies for fitness and well-being, as well as working in the Education Informatics Lab (EILab.ca) developing leading edge frameworks for Fully Online Learning Communities. She is a passionate advocate for teacher education, and she currently teaches in both graduate and undergraduate programs.

Marcelo Careaga Butter is Associate Professor and Associate Researcher at CIEDE-UCSC, Universidad Católica de la Santísima Concepción, Chile. He is Professor of History and Geography, Master in Education (in curriculum specialty) and has a PhD in Philosophy and Educational Sciences. Currently, he is Head of the Educational Computer and Knowledge Management Unit. His research focuses on Cybernetic Curriculum, Knowledge Management and Virtual Epistemology, and Integration of ICT in educational and intercultural contexts. Currently, he is a postdoctoral fellow in the final phase related to ICT and Knowledge Management in intercultural contexts at the University of Bristol, UK.

Zbyněk Filipi has a Master's Degree in Pedagogy, specialized in Computer Science, and a Doctorate in Pedagogy. He works at the Department of Computer Science and Educational Technology at the Faculty of Education at the University of West Bohemia in Pilsen, Czech Republic, which provides training for pre-service teachers, focused on computer science. He lectures on didactics and digital literacy. He is the author and co-author of articles focused on ICT in education. He has gained a wide range of experience in implementing projects for the professional development of teachers.

Inés González-González is a Professor in the Business Administration Department of the Public University of Navarre, Spain. She has a PhD in Business Administration – Accounting and Finances – from the University of Valladolid, and Executive MBA for the European School

Business of Madrid, both in Spain. She has worked as a Manager at several companies linked to Public Administration, and has worked as a Strategy Consultant. She has written more than 40 papers in prestigious international journals, having presented communications in national and international Congresses, and is directing doctoral research theses. She was Senior Researcher at i2TIC. Award in Education and Emerging Technology, 2017 awarded by The Financial Studies Center (CFS).

Ana Isabel Jimenez-Zarco is Associate Professor in the Business and Economic Studies of the Open University of Catalonia, Spain. She was Senior Researcher at i2TIC. She has PhD in Economics and Business from the University of Castilla La Mancha and Postgraduate in Building Models in Ecology and Natural Resource Management from the Polytechnic University of Catalonia. Both universities are in Spain. She was Evaluator at the European Union Program “Marie Sklodowska-Curie Actions Innovative Training Networks.” She is an author of over 70 national and international publications. Award in Education and Emerging Technology, 2017 awarded by The Financial Studies Center (CFS).

Gretchen Krehling McKay received a BA in Art at Colby College, USA, and her MA and PhD in the History of Art from the University of Virginia, USA. Currently, she is Professor of Art History and Chair of the Department of Art and Art History at McDaniel College, USA, and a speaker and consultant on active learning in the higher education classroom. She was the recipient of the 2015 Ira G. Zepp Distinguished Teaching Award at McDaniel College. She is also the Faculty Mentor to the McDaniel College Green Terror football team.

Miltiadis D. Lytras is Research Professor of Information Systems at Deree – The American College of Greece, with a research focus on semantic web, knowledge management, and e-learning, with more than 100 publications. He has authored/(co-)edited more than 45 special issues in international journals and 42 books. He has served as the (Co) Editor-in-Chief of 8 international journals (e.g., *International Journal on Semantic Web and Information Systems*, *International Journal of Knowledge Society Research*, *International Journal of Knowledge and Learning*, *International Journal of Technology Enhanced Learning*).

Christina Marouli is Assistant Professor of Environmental Studies at Deree – The American College of Greece. She has a long career as Educator in diverse contexts and as Consultant on environmental

issues, while she has worked for years in non-governmental organizations for women and children. She has founded and directed the Center of Excellence for Sustainability at the American College of Greece. She has been a recipient of a Fulbright scholarship for research on multicultural environmental education and has significant experience in experiential and active learning as well as in collaborative teaching and learning practices.

Anastasia Misseyanni is Associate Professor of Environmental Studies at Deree – The American College of Greece. She has research experience in the fields of Biochemistry and Molecular Biology. Her present research interests focus on innovative teaching and learning strategies in higher education and science pedagogy, with emphasis on active learning; also on Mediterranean biodiversity, green roofs, and sustainability in higher education. She has developed and taught many undergraduate natural science and environmental studies courses. She is coordinator of the Deree Environmental Studies program and serves as Head of the Department of Science and Mathematics at Deree – The American College of Greece.

Ronney Moreira de Castro graduated in Systems Analysis from the Higher Education Center of Juiz de Fora, Brazil. He is a Specialist in Computer Science as well as an MSc, both from the Federal University of Viçosa, Brazil, and a PhD Student in Information Systems at the Federal University of the State of Rio de Janeiro (UNIRIO), Brazil. He is currently Professor and Coordinator of the Bachelor of Information Systems at Granbery Methodist College, Brazil. He has experience in Computer Science, with emphasis on Software Engineering and Web projects. His research is currently focused on the area of computer education, more specifically on Active Learning.

Daniel Moscovici is Associate Professor of Environmental Studies & Sustainability at Stockton University, USA. He has completed a PhD in Environmental Planning & MS in Environmental Studies at the University of Pennsylvania, USA, and an MBA at Villanova University, USA. His main areas of interest include natural resource management, environmental pedagogy, regional planning, and land conservation.

William (Bill) Muirhead is the founding Associate Provost at UOIT. He completed a PhD at the University of Alberta, Canada, in the area of online and distance education. An active researcher, he has attracted and participated in more than \$8m of funding. He is the recipient of numerous awards including those from the Government of Alberta,

Canadian Association for Distance Education, Association for Media in Education, Industry Canada, and from UOIT for Excellence in Leading Teams. He has conducted research on aspects of online education, learning technology infrastructure development, and digital literacy in health-related fields.

Paraskevi Papadopoulou is Professor of Biology at Deree – The American College of Greece. Her research interests are focused in the fields of Structural Biology/Molecular Biophysics and Bioinformatics. She contributed to the development of genetic testing protocols for rare genetic diseases. Her current research engagement is on Mediterranean biodiversity and green roofs, in addition to higher education research and innovative ways of teaching and learning in STEM disciplines and big data analytics in Bioinformatics and Healthcare. She has served as Head of the Department of Science, Technology and Mathematics at Deree – The American College of Greece for 6 years.

Maria Cristina Pfeiffer Fernandes graduated in Engenharia Elétrica from Pontifícia Universidade Católica do Rio de Janeiro (1977), Brazil is Master in Production Engineering from Universidade Federal do Rio de Janeiro (1984), and has a PhD in Production Engineering from Universidade Federal do Rio de Janeiro (1989), Brazil. She has experience in education, with a focus on the following subjects: distance learning, collaborative learning, web-based learning environment, web, and education.

Linda Pospisilova is a University Teacher of Specific and Academic English in Bachelor, Master, and Doctoral programs of the Faculty of Chemical Technology, University of Pardubice, Czech Republic, with years of experience in eLearning and ePortfolio areas. She researches ePortfolio, student autonomy, and goal setting in language learning and deals with LMS Moodle course management, methodology, and administration. She is also a part of the Czech Pedagogy Wheel translation team, an author of several online courses which have been awarded EUNIS prizes, and a Mahara system administrator.

Eva Rimbau-Gilabert is a Human Resources Lecturer at the Economics and Business Faculty of the Universitat Oberta de Catalunya (Open University of Catalonia, UOC, Spain) and a member of the Digital Business Research Group (DigiBiz). Since 2004, she has taught at the UOC in the areas of human resource management, change management, and corporate social responsibility. She is also a member of the UOC's Academic Committee for the Doctoral Programme in

Information and Knowledge Society. She has served as Academic Director of several programs: the Bachelor's Degree in Labour Sciences, the Master's Degree in Work Safety, and the Graduate Studies of Business and Economics.

Lorayne Robertson is Associate Professor in the Faculty of Education at the University of Ontario Institute of Technology in Ontario, Canada. She specializes in online course design, program design, and quality assurance. Other research interests include investigations of the student experience and instructor role in polysynchronous online environments, with a particular focus on digital technologies and assistive technologies at the point of instruction in applied settings such as schools, colleges, and higher education. She is a former school principal, district superintendent, and education officer in Ontario, earning her doctorate at the University of Toronto, Canada.

Lucie Rohlíková has focused on higher education, distance education, and the use of technologies in education since 1998, and has been publishing her work on higher education continuously since then. She has gathered extensive practical experience in the use of blended learning for the training of academic staff, and has implemented several projects with a specific focus on training pre-service teachers and new faculty members. Since 2010, she has popularized mobile technologies enhanced learning, and she leads the Czech Pedagogy Wheel Team.

Sean W. M. Siqueira is Associate Professor at the Federal University of the State of Rio de Janeiro (UNIRIO), Brazil. He is Editor-in-Chief of the *RBIE: Brazilian Journal on Computers in Education*. He is the founder and coordinator of the Semantics and Learning research group and is a member of the special committees on Computers and Education (CEIE) and on Information Systems (CESI), both from the Brazilian Computer Society (SBC). His research interests are knowledge representation, web science (including social and semantic web), and advanced technologies for teaching and learning.

Eileen Sepúlveda-Valenzuela is an English Teacher from Universidad Católica de la Santísima Concepción, Chile. She has a Master in Technology and Knowledge Management in Education. She is a second year PhD Student at the University of Bristol, UK, thanks to Becas Chile scholarship. She has researched on the use of digital technology in education and has worked as research assistant for Universidad Católica de la Santísima Concepción. Currently, she is researching about intercultural dialogue in Chilean higher education.

Peter J. Shaw is Associate Professor at the University of Southampton, UK, specializing in interdisciplinary environmental science. He has a diverse background, holding degrees in Physics, Environmental and Ecological Sciences, and Biology. His interests in education encompass pollution, freshwater and marine science, resource and waste management, and contemporary environmental issues. He is a long-standing executive member of the UK's Committee of Heads of Environmental Sciences through which he has been involved with developing Professional Body accreditation of Environmental Science degrees.

Susan Stetson-Tiligadas has a PhD in Education with a specialization in Instructional Design for Online Learning. She has been teaching at Deree – The American College of Greece since 2006 in the English for Academic Purposes program and more recently in the MA TESOL program. She also helped develop the Online Faculty Training program and co-facilitates this program at the college. As an instructional designer, she has worked with subject-matter experts in Psychology, TESOL, Music, and Writing. Her research interests include motivational instructional strategies, instructional design theories, learner-centered instruction, and online professional development.

Emma Witt is Assistant Professor of Environmental Studies at Stockton University, a position she has held since September 2014. She completed a PhD in soil science at the University of Kentucky and an MS at the University of Minnesota. Her main areas of interest include implementing a range of active learning techniques in the classroom and field, as well as researching hydrologic responses to disturbance.

This page intentionally left blank

Preface

Undoubtedly, higher education is in an era of transition. The quest for fast integration of knowledge into innovative services and products, capable of promoting a socially inclusive sustainability vision for our societies, challenges the design of academic programs as well as the priorities of higher education top administrators and policy officers.

At the same time, the young generation is more and more attached to the use of technology in their daily lives; they have transformed into technology advocates, with various side effects – mainly their motivation not to use the monolithic, static learning content that is promoted in the traditional learning paradigm for decades.

In another context, the archetypal vision and mission of the academic learning process, especially as it relates to the cultivation of active citizens, personalities with critical thinking and creativity, aiming to contribute to better societies, is also being reconsidered.

What should be the vision for the learning strategies in higher education of our century? Which are the determinants of a learning philosophy promoting knowledge dissemination, the development of skills and competencies, and the ethos and social responsibility of students? Which is a viable and sustainable model for the integration of the numerous learning technologies that appear every few years and are promoted as panacea for any learning insufficiency? How can we facilitate a collaborative, distributed culture of mutual understanding, respect, and cross-fertilization between peers, disciplines, institutions all over the world? Is there a way in our turbulent times to cultivate peace-making processes and long-term sustainable – i.e., simultaneously environmentally friendly, socially just, and economically viable – interactions between nations, religions, and cultures based on shared values incorporated in modern educational systems? Which is, at the end of the day, the best contribution of education to the well-being and happiness of all the stakeholders involved?

With such big questions, our book is a rather humble effort to reposition the focus of our scientific teaching and learning community to the basics. In our opinion, active learning is not a simple didactic approach in a complex world. We define active learning as a holistic philosophy for a humanistic vision in higher education, where individuals, groups,

institutions, and nations contribute to a global transformation in balance with nature and with respect toward nature as well. Active learning is a transformative process that brings together knowledge artifacts, learning contexts, humans, and social problems as well as challenges for the present and future of our societies. The ultimate contribution of active learning is an innovative way of thinking, where reality and truth are not a case of black and white, where teaching and learning are an exploratory journey to the wealth of knowledge and different realities, and, finally, where nothing is taken for granted but the provision of a fruitful learning context, full of interactions, that can reveal to everyone his or her own path to inner achievement and fulfillment.

Active learning in our approach is a new way of understanding the dialogue between the accumulated knowledge, the inner inquiry of each person for personal development, and the social exploration for securing a better world for all. Active learning is about balancing personal motivation for self-fulfillment with group capacities for high impact contributions in business, culture, education, and every domain of human activity.

Active learning is a holistic approach. It is transparent in any aspect of higher education and has direct implications and prerequisites for administration, faculty, government, and various stakeholders. The resources required for active learning implementation should be investments with great return in terms of social value, sustainability, and development.

Active learning, furthermore, is about linking human minds and souls in a creative spiral of knowledge transformation and skills development at individual, group, and institutional level. It is hard to accept this in the context of a technocratic society where the specialization and the focus on core disciplines is something like an axiom.

Active learning is about interdisciplinary integration and intersection. This is an additional challenge for higher education. Without a systematic process of launching interdisciplinary programs and curricula, there will always be a critical lack of creativity and impact. It is time to link innovation with active learning strategies that interact with many disciplines at the same time. This will bring back the focus of education to the object of the matter. The learner is not an abstract concept. It is a complex entity with a personality, a psychological background, and cognitive capacities, developing within a certain social context. It is a real challenge for our times to reconsider the motivation we should prompt in the young generation. If the motivation is strictly related to narrow economic models of return on investment or employability

terms, our society will always be in lack of responsive actions to address the big social challenges of our times.

Our *Active Learning Strategies in Higher Education* is in fact a journey. At the end of its reading, researchers, academics, policy makers, and students will realize that this is just the beginning. This is because active learning requires a personal vision: the vision of an out-of-the-box education – to consider your learning process as a constructive process that brings you together with other people from all over the world. Active learning is about modifying your context, from the micro-world of your personal beliefs and understandings to a whole universe of magnificent human contributions.

We do believe that our times are the most suitable for such a humanistic shift in the design and delivery of programs in higher education. Global collaboration for the big challenges of our times, such as the preservation of our planet, poverty, socially inclusive and just development, smart and sustainable cities, mutual respect, and generation of new knowledge for providing sustainable solutions to social problems, is the vision for the active learning philosophy we propose. At the end of the day, it is about bringing more light into our souls. We do believe that we all deserve it. Let us imagine and work for a better world for all, for us – now and the next generations – and for all living beings. Learning can always make the difference, as it decreases ignorance which feeds our problems, can mobilize emotions, and can motivate our action.

Our next planned edition goes a step further. It provides practical guidelines for active learning that can lead to social transformation.

People can always make it! Margaret Mead – a renowned anthropologist – said “Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has.” We do believe in the capacity of the global community of creative minds and caring individuals to use active learning for the development of a new culture that will lead to more sustainable societies.

This page intentionally left blank

Acknowledgments

We are grateful to the great scholars and academics who contributed to this edition.

This page intentionally left blank

Introduction

*Anastasia Misseyanni, Miltiadis D. Lytras,
Paraskevi Papadopoulou and Christina Marouli*

In the 21st century knowledge society, higher education (HE) is experiencing a multidimensional transition. Shifting from the traditional, lecture-focused classroom setting to more learner-centered environments, integration of knowledge from different disciplines, interdisciplinary collaborations, use of information and communication technologies (ICTs) to enhance learning, globalization, and internationalization of HE, as well as emphasis on sustainability are some of the elements of this transition. Innovation and creativity are key drivers of change. HE is a significant tool for developing well-informed and knowledgeable citizens, well prepared to face the international job market; it also plays an important role in developing socially responsible and creative individuals, ready to address contemporary global challenges; these roles need to be strengthened and reconceived today.

With this book, we attempt to explore active learning strategies used in HE; strategies that promote leadership, innovation, and creativity. Active learning is a term used by educators to describe a more “learner-centered” approach to teaching. It involves students “doing” things and reflecting on what they are doing. Active learning practices may range from simple methods such as interactive lectures and class discussion to case study analysis, role-playing, experiential learning, peer teaching, and flipped lessons. Active learning may involve problem-based, visual-based, collaborative, project-based, or game-based learning. The editors’ long teaching experience in natural sciences and information technology has led to an initial focus on strategies used in Science,

**Active Learning Strategies in Higher Education: Teaching for Leadership,
Innovation, and Creativity, 1–13**

Copyright © 2018 by Emerald Publishing Limited

All rights of reproduction in any form reserved

ISBN: 978-1-78714-488-0

Technology, Engineering, and Mathematics (STEM) disciplines; the book has been enriched, however, with chapters describing learning experiences from other disciplines as well. The challenge of having to deliver large volumes of information while escaping from the traditional lecture approach and trying to promote deeper learning by stimulating student engagement, motivation, and confidence is addressed. Active learning empowers learners, as it helps them develop more responsibility, participate in the construction of knowledge, and challenge mainstream thinking and opinions. And this is an essential step in the development of informed, socially responsible, and creative individuals.

The use of ICTs in promoting an active learning environment is also explored in this book. Emerging technologies and applications for Science, Technology, Engineering, Arts, and Mathematics (STEAM) Education and other disciplines have received growing attention in recent years from various perspectives. A key strategic shift in the focus of educational strategies is evident, from content-oriented approaches to a collaborative, dynamic, media-enriched evolving paradigm. It seems that we are at a crossroad where the traditional classroom-based model of education has to be critically enriched with technology-enabled, value-added components. Active learning, enhanced and supported by the use of ICTs, is a key element leading toward the new model in HE.

The overall scope and main objective of the book is to expose the reader to the latest developments in active learning strategies used in HE, to provide good examples of such strategies, and to inspire teaching for leadership, innovation, and creativity. The book also aims to serve as a reference edition as well as a guide for teachers, professionals, and researchers; it can also be used as a teaching material at undergraduate and/or graduate level in the relevant domain.

The book is divided into three main sections. The first section is more theoretical and includes two chapters that elaborate on the epistemology of Active Learning and its unique contribution to HE. Steps in designing active learning experiences based on different learning theories are also outlined.

In the second section, the authors' teaching experiences in undergraduate and graduate courses are presented in the form of "stories." Eleven different case studies, which explore different active learning approaches used in STEAM and other disciplines, are presented. This section starts with a more general chapter on "stories" from STEM disciplines and continues with two chapters relevant to the environmental studies field, with emphasis on formative assessment and fieldwork as ways to

increase learning and promote student engagement. A chapter on how to engage non-history students in an art history course provides an example of active learning in Arts/Humanities. Seven chapters in the second section include case studies that explore the use of ICTs in promoting active learning. Two of these chapters discuss online learning; one of them also emphasizes collaborative learning. Two chapters on technology-enhanced learning for pre-service teachers, a chapter on active learning in an Information Systems course, a chapter on the use of ICTs in an Accounting course, and a chapter on the use of digital portfolios are also included. The overall aim of this section is to identify and communicate innovative teaching and learning strategies, discuss challenges faced, and provide a guide for future studies on increasing learning effectiveness in different disciplines. It also aims to provide examples of how ICTs can improve the learner's experience and to show how new, advanced learning designs and educational models can expand the frontiers in applied learning technologies toward smart learning and a knowledge society vision.

In the last section, a new vision for HE is presented. A debate paper on the pedagogical legacies of Dorothy Lee and Paulo Freire and a chapter on a new vision for HE based on lessons from Education for the Environment and Sustainability are included. This section provides insights for strategic policy making in HE, as well as a guide for teaching and learning that is fit for contemporary societies that need cultural and social transformations to effectively face significant environmental, social, and economic challenges.

The editors of this book aim to promote a humanistic vision in universities and colleges, linking education to sustainable development,¹ prosperity, and socially cohesive and caring communities. They suggest that HE – and all education – today should be appropriately designed for individual change, empowerment, integration, and social transformation. As authors and editors of this book, we believe it is a unique value proposition for HE.

¹In this book, we use sustainable development to underline the need for a balanced and harmonious relationship between human societies and the environment, an integrated approach to environment – society – economy and culture. Sustainable development and sustainability imply an integrated and deeply ethical approach, looking forward to the future, as was discussed in the document “Our Common Future” prepared by the United Nations World Commission on Environment and Development, 1987.

As stated above, the target audience of this book are educators and researchers, undergraduate and graduate students in the area of teaching and learning in HE. The book can also serve as a guide for educators and researchers; it can provide insights into pedagogies of engagement and give lessons and ideas for teaching and learning in specific fields. It may become a start for exchanging ideas and promoting research on the scholarship of teaching in HE.

A more detailed summary of the content of the chapters based on the chapter abstracts is presented below.

Chapter 1 concerns itself primarily with questions of how students in HE studies can best acquire, apply, create, and share knowledge. It examines the epistemological claims of the supporters and detractors of active learning while simultaneously exploring the nascence and development of some of the major understandings that presently underpin an epistemology of active learning. While the focus of earlier works may have been on changes that HE instructors should make to improve student understanding of key STEM concepts, this chapter addresses changes in the roles of both students and instructors as the co-creators of active learning environments and learning communities. A particular focus is given to the significance of metacognition as a critical skill that enables students to assess their own learning and also critically assess sources of information. The chapter includes a framework that indicates trends toward high-impact active learning skills for students in STEM HE and the research which theorizes and supports these new instructional imperatives.

Chapter 2 outlines the potential steps to take in designing active learning experiences based on several theories underlying the learning process. The chapter examines theories of learning and instruction including information processing, schema acquisition, and cognitive load theory. An explanation of how these theories support problem-centered learning as well as a rationale for the need to help learners develop domain-general, flexible problem-solving skills that will transfer to future needs and contexts is presented. The second half of the chapter focuses on designing active learning experiences based on: the selection of real-world problems as the foundation for learning, activating prior knowledge, demonstration of the process or concept, multiple opportunities for practice with relevant scaffolding, and the chance to integrate that knowledge into the learners' own context. Examples of assessments, strategies, and activities to foster active, problem-centered learning drawn from the literature are also provided.

Chapter 3 discusses the active learning strategies used in STEM disciplines and analyzes the potential of active learning to redefine the value proposition in academic institutions. After providing the theoretical underpinnings of active learning as an evolving practice, an attempt is made to connect it with different learning theories and present an integrative model in which institutional strategies, learning strategy, and ICTs work synergistically toward the development of knowledge and skills. In this chapter, the authors present the results of a survey examining “stories” of active learning from the STEM disciplines, identifying good teaching practices and discussing challenges and lessons learnt. The key idea is that active engagement and participation of students is based on faculty commitments and inspiration and mentoring by faculty. The authors finally present a stage model for the implementation of active learning practices in HE. Emphasis is placed on a new vision for HE, based on systematic planning, implementation and evaluation of active learning methods used, collaboration, engagement with society and industry, innovation and sustainability, for a better world for all.

Chapter 4 is a case study from the environmental science field. It focuses on a specific first-year course (module) offered at the University of Southampton, UK. “Environmental Science: Concepts and Communication” aids students in their journey into Environmental Science by preparing them to face the challenges of university study and beyond. It thus engages students in independent learning and provides them with opportunities to develop and enhance the skills necessary to do so. Formative and student-led activities and tasks are considered important tools to achieve this aim. This chapter provides an overview of selected formative and student-led activities with focus on methods and approaches, values and benefits, and the practicalities of delivery. Three assessments are reviewed: a practice essay, a communication exercise, and a practice presentation. The intended benefits and value of these assessments are (1) engagement with environmental issues and topics, and (2) development and enhancement of study skills. The value of such work is only realized, however, with student engagement. Delivering this module has demonstrated that formative elements are most effective when orientated to tutor group activities. Motivation for engagement appears most effective when the visibility – or absence – of students’ work is brought to the foreground though working in small groups. There is added value in that the collation and sharing of feedback within a small group permits students to learn not only from their own work but also from the work of others.

Chapter 5 focuses on field-based education for environmental studies which has been a foundational principle for the Environmental Studies program at Stockton University, and began in 1971. Located within the 445,000-hectare Pinelands National Reserve, on an 800-hectare campus near Atlantic City, New Jersey, USA, two professors in the program discuss their rationale and experiences teaching students about the environment within the environment. Expounding on the interdisciplinary literature of field-based learning, the authors present four unique case studies including local and regional experiences, as well as student learning abroad. The first case proposes that learning outdoors might be beneficial for students with learning disabilities. This is exemplified during a one-week field study to the 2.4-million-hectare Adirondack Park & Preserve. The second instance reveals the benefits of working with local towns and environments; acting as consultants in a multidisciplinary capstone experience. Next, the authors show how on campus data collection and hypothesis formulation help students to learn about environmental design and statistical analysis. Finally, an international trip to the Caribbean opens the minds of students through a service learning project. While on campus, in town, across the United States or at an international destination, learning in the field gives students the opportunity to expand their knowledge through field-based active learning strategies.

Chapter 6 explores issues of quality teaching, learning, and assessment in HE courses from the perspective of teaching fully online (poly-synchronous) courses in undergraduate and graduate programs in education at a technology university in Ontario, Canada. Online courses offer unique opportunities to capitalize on students' and professors' digital capabilities gained in out-of-school learning and apply them to an in-school, technology-enabled learning environment. The critical and reflective arguments in this chapter are informed by theories of online learning and research on active learning pedagogies. Digital technologies have opened new spaces for HE which should be dedicated to creating high-quality learning environments and high-quality assessment. Moving a course online does not guarantee that students will be able to meet the course outcomes more readily, or that they will necessarily understand key concepts more easily than previously in the physically co-present course environments. All students in HE need opportunities to seek, critique, and construct knowledge together and then transfer newly-acquired skills from their coursework to the worlds of work, service, and life. The emergence of new online learning spaces helps us to re-examine present higher education pedagogies in very deliberate ways

to continue, to maintain, or to improve the quality of student learning in HE. In this chapter, active learning in fully online learning spaces is the broad theme through which teaching, learning, and assessment strategies are re-considered. The key elements of the authors' theoretical framework for active learning include (1) deliberate pedagogies to establish the online classroom environment; (2) student ownership of learning activities; and (3) high-quality assessment strategies.

Chapter 7 describes and analyzes the result of an active, co-operative learning design adopted in "Change Management," an elective course in the University of Catalunya, Spain, which is a fully online university. The chapter describes the context and the foundation that supports the learning design, outlines the learning activities and their evolution, and presents the results of a student survey to assess the effectiveness of the design in reaching its main goals. The results of the survey suggest that students perceived this design as enhancing their teamwork competence, while being interesting and motivating, and useful to learn the course's content. Therefore, the desired goals were attained and the design was kept, with minor changes, in subsequent editions of the course. In addition, students without prior teamwork experience valued collaborative activities more than students who had previously worked in teams in other subjects of their degrees. In contrast, no differences were found for individual learning activities. This suggests that the design can be useful in introductory courses where students are asked for the first time to learn in virtual teams.

Chapter 8 is a case study from Humanities and Arts. It presents how an instructor in a Roman Art class at a US University managed to engage five football players; it provides an account of how she tried to engage the class as a whole. The author discusses the commitment she made to making each class period one in which an active learning technique was used, often paired with some lecture, sometimes not, to engage students and help them learn about Roman Art and Architecture. She discusses the type of assignments she thought would work, based on research and her own observation, as well as the results of a focus group held with the football players a year later. Football players tend to be kinetic learners and thus were chosen as the follow-up to see how the active learning techniques in this class met objectives. Specifically, this chapter discusses the inclusion of a *Reacting to the Past* game, a research project on "Daily Life in Ancient Rome," case studies where students had to create an artifact (a list, a floor plan, a propaganda program, etc.) in response to a prompt, and presentations

on different methodologies of interpreting an image from a Pompeian tavern.

Chapter 9 presents innovative approaches to active learning that were introduced into the teaching of pre-service teachers at the Faculty of Education of University of West Bohemia, Pilsen, in the Czech Republic. Over the last three years, the Technology Enhanced Learning course has seen substantial innovations in both the content and use of teaching strategies designed to prepare the students for their professional lives. The whole update of the course was implemented using the results of action research – all individual changes were rigorously tracked and analyzed. Besides practical activities with tablets and smartphones, during which students familiarize themselves with various types of applications and reflect on their use in teaching, the course was extended by the use of practical aids for the efficient inclusion of mobile technologies for teaching – the Czech version of Allan Carrington's Pedagogy Wheel. During the teaching, students work with internet applications and cloud services. Teaching is complemented with communication on the Facebook social network. A close link to professional life is achieved through workshops, which in-service teachers from elementary and high schools provide to pre-service teachers. A significant part of the teaching consists of co-operative projects between pre-service teachers and pupils of elementary schools. The innovative approach to active teaching in the Technology Enhanced Learning course is apparent even during the exam. In the course of the exam, students process, present, and defend a lesson plan for the implementation of an activity using digital technologies.

Chapter 10 examines how to apply effective teaching and learning strategies as an essential component in understanding the complexity of human groups, especially in educational contexts. To look for the relationship between the contributions that people make, it is critical to understand the singularities of cultures when developing innovations and to foster leadership in education. This chapter presents an experience developed in HE in Chile, focused on the ability of pre-service teachers to enhance the development of individual talents as an active teaching and learning strategy that aims to create a society made up of integrally developed people in educational contexts. In addition, the authors make reference to the use of virtual learning environments as a vehicle to connect students between physical and virtual boundaries. This strategy is based on the Talent Management Model which was implemented in intercultural primary schools by professors and pre-service teachers from the south of Chile. The virtuality dimension

promoted the detection of individual traits of students and contributed to the development of a cultural identity. Additionally, it offered theoretical and practical knowledge that implied an innovation in the training of future teachers.

Chapter 11 examines how the use of active learning techniques can significantly improve the teaching–learning process in Information Systems courses, since the content is explored in a more interactive, participative, and relaxed way. Although expositive classes are still broadly used in Brazil, in this chapter the authors present some active learning techniques as well as experiences of their application in Information Systems K-12, undergraduate and graduate courses in Brazil. As a result, the authors have noticed learning has been more effective and students have been motivated by the use of these active learning techniques. Although used in the context of Information System courses, the techniques could be adapted to other scenarios.

Chapter 12 presents a case study from the field of Accounting. Even though students increasingly demand the integration of the varied technologies and mobile devices in the learning environment, educational systems of the public universities continue to be traditional. In this chapter, a teaching innovation for first-year university students using the Socrative app is presented. The authors of this chapter investigate how the university can combine ICT with traditional methodologies of learning, in order to increase student interest in the subject and awakening students' passion and vocation for the accounting area.

Chapter 13 makes reference to a constant growth in digital portfolio use in tertiary education in the recent years. Portfolios are used by educational institutions for assessment, as a showcase of both student and institution work, and with an increasing trend also as a tool for higher employability of graduates and support of lifelong learning. This chapter introduces concepts of portfolio, digital portfolio, language portfolio, autonomy, and self-assessment. It approaches both positivist and constructivist paradigms of digital portfolio and presents examples of ePortfolio implementation at the University of Pardubice, Czech Republic. Selected examples of good practice with respect to autonomous learning, experiential learning, and international cooperation are also given.

Chapter 14 can be described as a debate paper in which the author reintroduces the anthropological and pedagogical insights of Dorothy Lee and Paulo Freire in the ongoing debate on active learning and HE. These insights refer in the case of Dorothy Lee, on “valuing the self” of the student, and additionally on learning (values) from “remote

cultures,” and last but not least on the meaning of freedom and autonomy in the teaching/learning process. The author points a few selected lessons and contributions from Freire: (1) the socio-cultural anchor of freedom and autonomy, (2) the view of education as a tool for raising-awareness, critical thinking, inspiration, hope, empowerment, cultural action, and social transformation, and (3) the view on citizenship education. The author discusses in this regard, the significant role assigned by Dorothy Lee and Paulo Freire to the neglected notions of dialogue, freedom, culture, self, autonomy, and structure. Lastly, the author argues in favor of reincorporating the pedagogical insights of Dorothy Lee and Paulo Freire in the curricula and structure of HE, and also reminds those concerned with upholding democracy that these formative values and concepts were acknowledged in the early conception and development of active learning.

Chapter 15 presents a new vision for HE based on lessons from Education for the Environment and Sustainability. Environmental Education (EE) and its descendant Education for Sustainability (EFS) or Education for Sustainable Development, by definition, propose and adopt active learning and experiential methods, as they seek to prepare people that will work for a healthy environment and better societies. And this is where the difference lies between EE/EFS and the generic active learning approaches. EE or EFS are committed active learning approaches; they have an explicit goal to work for social – environmental change. The transition from learners to active learners is addressed by active learning, which however assumes that active learners will also become responsible and active citizens. EE and EFS have however demonstrated that this is not an obvious development. After a discussion of the main characteristics of EE/EFS, this chapter explores what facilitates the transition from active learners to active citizens, based on lessons from EE and EFS. Finally, it reflects on the implications of these lessons for HE and a new vision for HE in contemporary societies and a brief guide for educators and Higher Educational managers are proposed. The authors propose the following typology of educational purposes – i.e. individual change, empowerment, integration, or social transformation – and corresponding instructional methods and tools. Higher education institutions and instructors (or academics) should be clear about the purpose of the educational praxis and instructors should choose the pedagogical methods and tools that match the selected purpose(s) in order to facilitate the transition from active learners to active and responsible citizens.

This book presents best practices for effective active learning and teaching in HE. It includes case studies of active learning approaches adopted at universities in different countries and continents and in different disciplines. It presents best cases of technology-driven learning innovation, as well as insights on HE for sustainable societies. It is a book that highlights the importance of collaborative knowledge sharing, exploration, and creation, involving active engagement of both students and instructor – and even the local community – all as actors of the same play. It emphasizes an integrated pedagogical approach that uses engaging and collaborative learning methods, problem solving, technology-driven learning innovation, collaboration with the community, and other teaching strategies, within the explicit context of a new civic ethic (e.g., personal issues are social problems).

The insights gained in this book could be further enriched with more studies on the effectiveness of different active learning methods. It would be interesting to explore what active learning methods effectively stimulate not only creative thinking but also lead to change in values and behaviors. A systematic study of student performance in classes where active learning is used, as well as a more thorough analysis of teachers' conceptions of effective teaching and an exploration of students' attitudes on the effectiveness of learning methods – also in terms of behavioral change – could provide further insights into how transformative learning can be achieved.

This edition is the first part of a sequence of books already planned. The main goal of this series is to explore active learning pedagogy and methods within the present social context and challenges, as well as the “keys” that can make active learning empowering and transformative, leading to more humane, caring, and sustainable societies.

The objective of this first book, *Active Learning Strategies in Higher Education: Teaching for Leadership, Innovation and Creativity*, which you currently hold in your hands, was to explore active learning practices internationally and introduce our Active Learning Philosophy. We do believe that the variety of chapters and the adopted teaching and learning strategies that have been communicated in the three sections of the book summarize the main aspects of this philosophy: innovation and integration; creativity and collaboration; and leadership and social action. The understanding of the philosophical underpinnings of active learning theory and the challenges of our times, and their integration in HE practices can cultivate an exploratory, collaborative, empowering, and transformative active learning philosophy that can lead to

sustainable societies. The role of technologies is also introduced without entering into details.

The next book will concentrate on transformative learning. An indicative title is *From Active Learning to Transformative Learning: Moving Beyond Boundaries and Disciplines*. In this edition, the focus of our discussion will be on a detailed sophisticated methodological framework for the design of transformative active learning programs, with a focus on HE. The greatest challenge is related to the fragmented nature of knowledge and organization in HE institutions. Contemporary social and environmental challenges require integrated approaches and the liquidation of boundaries – between humans and the environment, me and the “other,” disciplines, the university and the community. Our unique value proposition is that Transformative Active Learning will be one of the most significant enablers of this innovative, out-of-the-box, technology-enabled education and thinking. For this reason, in the chapters of this edited book, we will present best practices of Transformative Learning; interdisciplinary – multidisciplinary practices in STEAM.

We do hope that our readers will value the individual contributions in each chapter and will also be able to be carriers of our active learning vision. In simple words, our effort will be successful if we find more advocates for active and transformative learning and its adoption in universities and colleges, so that HE:

- Promotes individual contributions and seeks for social humanistic visions for the learning process.
- Acknowledges the value of each individual knowledge artifact but recognizes and supports its integration with knowledge elements from different disciplines.
- Promotes the development of personal values, skills, and competencies but also connects it with a socially beneficial context for their exploitations.
- Compensates group efforts in learning content interaction and explorations and builds connections between universities and communities, different cultures, civilizations, and religions.
- Promotes creativity, imagination, and emotional depth of students along with knowledge acquisition and development – all as equally important and complementary.
- Constructs a dialectic, not authoritarian, communication channel between faculty and students.

- Informs HE administration about the non-countable benefits of active learning at institutional level.
- Promotes employability with advanced ethos and enhances personalities of individuals.
- Cultivates a participatory culture in academia at all levels.
- Makes learning an intellectual process contributing to a vision for a better world for all, designed for active citizens with increased responsibility.
- Makes HE more relevant for a socially inclusive sustainable development.
- Builds bridges between individuals, groups, institutions, and nations.
- Envisions a socially beneficial and effective use of resources in Academia, Industry, and Society.

This page intentionally left blank

SECTION I
ACTIVE LEARNING IN HIGHER
EDUCATION: A THEORETICAL
BACKGROUND

This page intentionally left blank

Chapter 1

Toward an Epistemology of Active Learning in Higher Education and Its Promise

Lorayne Robertson

Abstract

This chapter concerns itself primarily with questions of how students in higher education studies can best acquire, apply, create, and share knowledge. Over the past several decades, multiple forms of active learning have been proposed in order to increase student engagement and deepen their understanding. This chapter, accordingly, examines the epistemological claims of the supporters and detractors of active learning while simultaneously exploring the nascence and development of some of the major understandings which presently underpin an epistemology of active learning. While the focus of earlier works may have been on changes that higher education instructors should make to improve student understanding of key STEM concepts, this chapter addresses changes in the roles of both students and instructors as the co-creators of active learning environments and learning communities. A particular focus is given to the significance of metacognition as a critical skill that enables students to assess their own learning and also critically assess sources of information. The chapter includes a framework which indicates trends toward high-impact active learning skills for

Active Learning Strategies in Higher Education: Teaching for Leadership, Innovation, and Creativity, 17–44

Copyright © 2018 by Emerald Publishing Limited

All rights of reproduction in any form reserved

ISBN: 978-1-78714-488-0

students in STEM higher education and the research which theorizes and supports these new instructional imperatives.

Keywords: Active learning; metacognition; authentic learning; problem-based learning; project-based learning; authentic assessment

Introduction

The Oxford online dictionary informs readers that *epistemology* is derived from the Greek word “to know how to do.” An epistemology is a *theory of knowledge* which is designed to explain the different ways in which one can acquire knowledge or competence. A key epistemological question for those teaching higher education might initially be, “How do higher education students come to know something?” but in the more complicated current era of Web 2.0, the Internet of Things, and increasing expectations of higher education graduates from the world of work, the question becomes “How do higher education students BEST come to know something?” We could see this as an imperative, because the future will be impacted by how students in higher education courses across the globe gain competence in their chosen fields and disciplines. The future will also be impacted by how today’s students apply their knowledge in order to solve problems; how they communicate, reason, argue, justify, and confirm or refute their assumptions and hypotheses; and then how they draw conclusions, and mobilize and share their knowledge.

As instructors in higher education, our teaching is grounded in our conceptions (and our assumptions and theories) of how people learn. We must, however, be ever mindful that, for most of our students, the academy will not be their career destination. Our students will move into the world of service and the world of work where they will need to know how to function well. The world of work our students will inhabit is continually changing and demanding new skills. This begs the question of how our epistemological assumptions align with these new global imperatives and changing contexts. Are we preparing our students optimally for their career choices? How best can students in higher education acquire the requisite knowledge, skills, and values to function with dexterity in new global knowledge economies? These are questions that move us beyond concerns of efficiency and effectiveness

to consider how higher learning can best model ways of *coming to know* or ways of *theorizing learning* in order to build capacity in the next generation of global knowledge workers.

When the epistemology is that of *active learning*, the questions about knowledge become much more strategic and targeted. What understandings constitute the key aspects of an epistemology of active learning? Are there explanations that encompass the full grasp of active learning and its potential in higher education? Where and how did this theory originate? In which pedagogical paradigm(s) does active learning claim its roots? What are the key elements that need to be uncovered and understood in order to grasp the full scope of active learning's claims? In other words, beneath the surface, what are active learning's epistemological assumptions? These questions help us to understand the origins of the active learning paradigm and the reasons why this shift in approach is gaining acceptance and currency.

Next, we need to review the evidence-based claims made about active learning, particularly those claims that have been made in the fields of STEM and STEAM. What is the scope and breadth of active learning's claims about teaching and learning in STEM higher education? Who has made these claims, and in what contexts are the claims made? We also want to understand whether or not this is a passing phenomenon or if the concept of active learning has been shown to have staying power. How significant is active learning's reach in higher education today? What is the extent and capacity of active learning's promise to meet new imperatives to act and think globally? How responsible and responsive is the theory of active learning toward solutions to long-standing social and scientific problems, such as global warming? All of these questions need to be explored in some depth to detail the scope of an epistemology of active learning.

There are also practical questions to be considered, such as how an epistemology of active learning can inform teaching, learning, and assessment in higher education in the digital era. What are the actualized (not theorized) forms of active learning in practice? What does active learning *look like* across higher education disciplines and courses? In which contexts or disciplines has active learning come to be understood in more meaningful ways? If active learning is desirable, then how does one acquire knowledge about active learning, gain competence, and then evaluate active learning approaches in higher education disciplines? How do instructors and students make sense of active learning experiences epistemologically and under what circumstances? How does

a theory of active learning apply when the courses are offered online in a range of multi-synchronous settings?

Other considerations include an examination of the reasons why active learning may not be adopted. What are the epistemological assumptions of active learning's detractors? Into which contexts or disciplines in higher education is an epistemology of active learning less integrated and what are the sources of this reasoned skepticism? All of these questions are designed to help to apply an epistemology of active learning to the broader contexts within higher education practice.

Beyond the practical, there are even deeper questions to unravel about active learning. An epistemology of active learning seeks to identify the claims that have been made about active learning and distinguish between evidence, beliefs, and opinions. On what basis do active learning supporters claim its connection to deeper learning, for example? Similarly, how have the connections between active learning and student engagement been theorized or researched? An epistemology of active learning should encourage readers to become engaged beyond simply seeking information about active learning and how it is realized in practice. If you, the reader, join in to the epistemological journey on active learning in this chapter, you will come to better understand active learning's origins, the claims of its supporters (and detractors), and working through the chapter, you should reach some reasoned conclusions about active learning. This is the essence of the epistemological journey of this chapter.

What Is Driving the Shift to Active Learning?

Active learning has been defined by Prince (2004) as any type of instructional method which engages students in their learning process and requires meaningful (relevant, authentic) learning activities as well as requiring students to think about what they are doing (metacognition). This implies that students will eschew roles as passive recipients of information, and instead contribute actively in classes. In defining the active learning methods that are most relevant for engineering education, Prince selects three: collaborative, co-operative, and problem-based learning and concludes that empirical research supporting active learning is "extensive" (p. 3). Within the context of engineering education, he finds that instructors may demonstrate different levels of acceptance and understanding of active learning. While it is common for engineering students to participate in active learning through tutorials

or assignments, how active learning can be realized in the lecture or higher learning classroom still requires some explanation. Nonetheless, Prince's (2004) review of the research provides measured support for active learning practices in higher education.

Active learning includes the engagement of the student at a new level of awareness of their own learning, or metacognition, which is defined by Flavell (1979) as *a means of cognitive monitoring*. He outlines the elements of metacognition as follows: metacognitive knowledge (one's beliefs about one's learning capacity); metacognitive experiences or conscious recognition of understanding or misunderstanding; learning goals; and the actions or learning strategies that help one learn. Flavell recognizes that the students should be active participants in the monitoring of their own learning. He also theorizes that metacognition and self-regulation can be taught and should include the scrutiny of information which he describes as: a more conscious awareness of the source of a message, the quality of its appeal, and the related consequences of attending to inputs from different sources (Flavell, 1979). In essence, Flavell was advocating an early form of critical literacy skills, now more requisite than ever due to the proliferation of online information sources.

It is not theory and research results alone which are driving a continual shift toward more active learning in higher education but also new educational imperatives. One of these imperatives is a predicted *skills gap* – or the prediction that there will be insufficient talent to meet the global demands for employment in the decades ahead. Olson (2015) reports that the global market will experience a shortfall of 40 million skilled college graduates, a shortage of 95 million workers in the advanced economies, and a shortfall of 45 million secondary and vocational school graduates in the developing world through the year 2020 and beyond. While Olson does not place the full responsibility for addressing this shortage on education, he finds that many students who pursue 4-year degrees without vocational training or education *outside of the STEM subjects* will be “ill-equipped” for teamwork and knowledge work (Olson, 2015).

A second type of skills gap is more of a perception gap, as reported recently by Cukier (2016), who compares how students graduating from one Canadian university rate their skills with how their employers rate those same skills. The results indicate that the students did not have accurate perceptions of their skills compared to the level of skills expected by their employers. For example, while the students rated themselves above 90% in communication proficiency, their employers

saw them as less than 50% proficient. Similar ratings were seen with gaps related to how the students saw their ability to learn on the job (as 93% proficient) versus how employers rated their ability to learn on the job (as 53% proficient). Employers also reported that less than 25% of recently-hired graduates had the required proficiency in digital tools and in ethics (Cukier, 2016). These findings underscore a need for students to be able to gain an accurate assessment of their own goals, skills, and ability to learn while they are in school. Prince (2004) finds that in order for students to more accurately assess their interpersonal skills related to what work requires, they need opportunities to practice these skills in classrooms that employ active learning in project or problem-based learning scenarios, and they need opportunities to assess their own and their group's collaborative skills using metacognition.

Emergent awareness of these skills is leading instructors to reconsider which learning aptitudes take priority in the 21st century. For example, in an era where there are multiple perspectives on every issue, and multiple claims of *truth*, how do students wrestle with moral and ethical implications in a landscape with many disparate claims? One example is the ethical and moral considerations behind releasing government information in leaks that inform citizens but may weaken organizations. Fuchs (2011) applies a Foucauldian discourse analysis to discuss how counter-surveillance activities such as WikiLeaks invite the discussion and interrogation of surveillance as a form of control, and how it can be used also as a mechanism of emancipation. In an increasingly complex world, students will need to learn how to consider and debate these types of ethical complexities.

The world of work requires skills of communication and collaboration. Early studies in the area of group learning were initiated by D. Johnson, R. Johnson, Holubec, and Roy (1984) who describe this as *co-operative learning*. They defined the concept of *positive interdependence*, which is the perception that one group member does not succeed unless the others in the group succeed through sharing resources and mutual support (D. Johnson & R. Johnson, 2009). This concept is echoed by others such as Steiner and Posch's (2006) description of *mutual self-responsible learning* in sustainable development studies.

A third imperative driving the need to shift the paradigm toward more active forms of learning has been the (repeated) identification of skills needed to work in the knowledge economy. Trilling and Fadel

(2009) report that the following skills will be required of graduates in the 21st century:

- 1) *Learning and innovation skills*: critical thinking, problem solving, communication, collaboration, creativity, and innovation.
- 2) *Digital literacy skills*: information literacy, media literacy, and information and communication technologies (ICT) literacy.
- 3) *Career and life skills*: flexibility, adaptability, initiative, self-direction, social and cross-cultural interaction, productivity, accountability, leadership, and responsibility (p. xxvi).

Pellegrino (2006) reports similar findings about the needs of the future workforce based on research conducted on behalf of an American economic think tank. Not only will skills of “adaptive expertise” (p. 2) be required of a skilled workforce, but this type of adaptive learning needs to be *modeled by the instructors* who are preparing the workforce. Pellegrino cites some shortcomings in the present education system – which he believes can be remedied through *principles of learning*. The first principle is that education must become more personalized, recognizing that individual learners approach new learning with pre-existing beliefs and perceptions that they acquire through their life experiences. Educators need to more closely understand what students know and then help them to construct new learning. Pellegrino sees that the present reliance on standardized assessments in the United States may not be providing the kind of information instructors need to understand students’ misconceptions.

Second, Pellegrino argues that students need assistance to organize knowledge using models and conceptual frameworks to help with information retrieval. This is at the heart of helping students develop deeper understanding; they need to see relationships and patterns and recognize cognitive dissonance in order to gain meaning from what they are learning. He forecasts that very powerful information technologies will be as ubiquitous in education as they are in people’s out-of-school lives, and that these new technologies will exponentially and fundamentally change communication and education practices (Pellegrino, 2006).

In views which are reminiscent of Flavell (1979), Pellegrino’s third principle encourages more metacognition. Students need opportunities to verbalize their thinking and make it visible. Methods of inquiry can be taught, including methods to help students activate their prior learning, and these inquiry methods should be taught across courses and disciplines. These methods include problem and project-based learning

where students are challenged to think deeply about their knowledge and then apply it. For this to happen, educators need to develop repertoires of diverse instructional approaches to support the development of complex learning skills in students (Pellegrino, 2006).

Bransford, Vye, and Bateman (2002), in a landmark review of decades of research on cognition, proposed the How People Learn framework as a theoretical tool to guide the design of learning and to analyze the quality of the learning experience. The framework has four lenses, indicating that high-quality classrooms are learner-centered, knowledge-centered, and assessment-centered, and take place within a community of learners. Their work was key in acknowledging a collective community responsibility for learning outcomes (Bransford et al., 2002).

According to Dede (2008), a shift in epistemology occurred with the advent of Web 2.0, redefining higher education through the multiple ways that Web 2.0 epistemologies contrast with more traditional, classical studies. For example, Wikipedia is redefining who is an expert by constructing knowledge through the collaborations of anonymous volunteers and the exchange of different viewpoints. Students now require significant new skills to help them understand how to determine an expert view on a subject (Dede, 2008). Technology has the potential to assist with many new learning imperatives, including opening education to online learning so that it is more accessible to more people (Garrison, Anderson, & Archer, 2001; Jacobsen & Lock, 2004; Pellegrino, 2006).

Technology has continued to change rapidly even while many of the present higher education instructors have been in their roles. This is requiring continuous shifts in learning how to help students learn using their digital skills. As Jacobsen and Lock (2014) state, “An important job for all educators is to enable learners *to author using the media of their time*” (italics added). Speaking in the context of teacher preparation programs, Jacobsen and Lock find that teachers in training need to be able to respond to the emerging technologies that they will face as their future students become more technologically adept. This advice for preservice teachers can also apply to instructors in higher education.

Another significant reality shift for higher education has been referred to as the *massification* of higher education (Hornsby & Osman, 2014). This global trend is positioned as a benefit to society as it builds health and security for the people of the world through education. As a result of this trend, more students who might not have been able to

attend higher education in the past are now enrolling. In studying this phenomenon, Hornsby and Osman remind us that in order for a much more diverse group of students to be successful, shifts in multiple areas are required; these include the design of the curriculum, the design of the classroom environment, the instructional techniques, and the assessment methods. All of these key aspects of higher education influence student learning and engagement (Hornsby & Osman, 2014).

In summary, then, these examples of imperatives for education in the 21st century all point to a need to transform education to make certain that schooling in general, and higher education in particular, becomes more personalized and tailored to individual student learning. In order for this to happen, instructors in higher education will, realistically, need to build larger repertoires of teaching and learning approaches in order to tailor education to adult learners. While this could imply that the program and the instructor need to change the most, the reality is that student roles must similarly transform. Students will need to build skills of self-assessment, self-awareness, and metacognition in order to understand how they learn best, and how they can work collaboratively to prepare for work and for life. They need to become participants in the design of their learning and co-creators of the learning communities in their classrooms. The shift from teacher-centered learning to student-centered learning has implications for everyone involved in the higher education enterprise.

Changing Pedagogical Paradigms

One of the central contrasting paradigms which has been employed to empower students to take more responsibility for their learning is the conceptual model comparing teacher-centered to student-centered learning. Some of the original philosophical underpinnings and advocacy for more student-centered learning originated with Freire's (1970) explication and criticism of the "banking model" of education (p. 72). In the banking model, students are positioned as passive receptacles to be filled with knowledge; instead, students should be active in constructing knowledge. This paradigm shift includes a critical stance toward a *one-size-fits-all* type of education where a single source of messaging (the lecture or the text) delivers the same message in the same way to all students, and the students expect the instructor to prepare, organize, and present the learning. How the message or the information was delivered was the responsibility of the instructor; how the information

was received, retained, and reported was considered to be the responsibility of the student. This model is presently under significant scrutiny and revision.

Freire viewed the banking model as a form of oppression because it placed the teacher in a position of power over the students and their learning. In the banking model, the teacher's knowledge was privileged and there were privileges around *voice* – the teacher was the speaker and the students were listeners. Choices such as the sources of information (textbook, lectures) and assignment modalities were also made for the student by the teacher. In this mode of learning, Freire viewed the students as objects in the learning process rather than the subjects of the learning, or as persons (1970). While Freire's theory may not have had immediate uptake in STEM, discussions about the need for students to engage more deeply in their learning in various STEM disciplines have come to similar conclusions about the need for change (Biggs, 1999; G. Catalano & K. Catalano, 1999; Wieman, 2007).

Biggs (1999), in writing about "*What the student does,*" focuses on the ways that higher education instruction should change in four simple steps:

1. Ensuring that students see what the objectives are, what the learning plan is, and how the objectives match the assessment tasks;
2. Working so that students are motivated by the course, program, or instruction;
3. Making the classroom safe so that students feel free to focus on tasks (without unscheduled tests, for example); and
4. Ensuring that students can work collaboratively and dialogue with peers (Biggs, 1999). It is noteworthy that Biggs views the paradigm shift as the responsibility of the instructor without acknowledging that students need to change their roles, also. This overall approach is changing.

Wieman (2007) outlines his concerns with student retention of knowledge and understanding of concepts in physics courses. His work with university physics students began initially in the United States, then continued in Canada through several decades. Though he and colleagues prepared well and professionally for the traditional lecture format, evidence of student learning outcomes and skills development were less than optimal. He noticed first that students who experienced success in the classroom were *clueless* about how to begin to solve research projects, but, after a few years of research, were *transformed* as learners (Wieman, 2007, p. 10). As a result, Wieman began to research and

amass evidence with respect to student learning in physics lectures, finding that student retention of information after traditional (lecture) instruction was 10% after 15 minutes. While the gain in conceptual understanding from lectures was measured at 30%, he found, surprisingly, that students regrettably gained more novice-like beliefs after a year of physics instruction (rather than building expert beliefs). The consistency of his findings led him to conclude that, “The traditional lecture is simply not successful in helping most students achieve mastery of fundamental concepts. Pedagogical approaches involving more interactive engagement of students show consistently higher gains on the FCI [Force Concepts Inventory] and similar tests” (Wieman, 2007, p. 11).

Using research that he initiated with his colleagues, Wieman began to unravel the puzzle, looking to cognitive science on how people learn. He found that expert professors have a mental structure to organize their learning and know how to check new information with prior learning, and science instructors need to encourage students to organize and apply the information of the discipline in similar ways. People learn by adding to their prior learning and making sense of the new information. In order for this to happen, effective teaching needs *to engage students in thinking deeply about a topic at an appropriate level, and then monitoring their understanding*. Students, in turn, need to become engaged in this process in order to be successful. This is, in essence, Wieman’s epistemological outlook on teaching and learning in physics (Wieman, 2007).

Without using the term *constructivism*, Wieman’s findings about physics instruction match the assumptions of constructivism; that students build meaning through active engagement with the material and with guidance to build on their prior learning at an appropriate and attainable level. Similarly, G. Catalano and K. Catalano (1999), in a discussion about student-centered learning in engineering education, note that the view of the *instructor as the center of the learning process* is outdated. They identify the new roles for engineering instructors as follows:

- *Modeling the thinking and processing skills*: this includes modeling how to make sense of an issue or problem;
- *Knowing where students should be cognitively*: strategies here include employing the range of Bloom’s (1956) taxonomy to develop the outcomes of the course, and sharing with students how higher-order thinking is required for solving problems;
- *Developing questions to facilitate student growth*: questions should range from recall to more complex questions which require interpretation and prediction;

- *Using visual tools to show connections*: suggesting that instructors use mind maps or graphic organizers to categorize learning or to show relationships and connections;
- *Providing group-learning settings*: encouraging students to solve problems in groups;
- *Using mental models*: employing analogies and metaphors as models to frame learning and debates, and encouraging students to create metaphors; and
- *Providing lower-risk mechanisms for student input*: asking students to explain their thinking using low-stakes mechanisms such as comment sheets and informal quizzes (G. Catalano & K. Catalano, 1999).

Although many student-centered activities have been attempted and documented in the 18 years since these suggestions were provided, discussions have not been clear about the changing roles of both the instructors and the students. I would argue that it is not the role of the instructor alone to determine students' prior learning and cognitive strengths. Students need to be aware of their own backgrounds and experiences and come to class prepared to discuss their perceptions and assumptions in order to build new understandings. While the instructors can model mind maps and cognitive maps for students, the students need to construct models and concept maps for themselves and for the benefit of other learners. Students will also need to build their own skills and capacity toward understanding how learning happens, including their own learning. Added to that, they will need to know how to apply their learning in authentic contexts that mimic or are situated in real-world problems.

Jourdan, Haberland, and Deis (2004) argue that there is a clear shift toward *the student as the person most accountable for whether or not learning happens* in the digital era. They state,

Higher education is becoming what it has always surreptitiously been through the ages: the internal metamorphosis by the learners themselves, brought about by their own agency through a number of educational resources, including interaction with faculty, content of the educational process, and the institutional environment...Students are in a sense the producers of their own education and are ultimately responsible for their own development and outcomes. (p. 24)

Trilling and Fadel (2009), however, theorize that the shift toward less teacher-centered learning and more student-centered learning alone will be *insufficient* for the complex learning of the decades ahead. Students will need some direct instruction but they should not rely on this; students need to learn how to exchange knowledge. Students will develop sources for their learning outside the academy because learning outside-of-school is becoming part of everyday life in a global, digital community. While some teacher-directed skills will be needed in the decades ahead, the scale will tip toward focusing education to build on what students already know, and what they need to learn. Future learning will be more personalized, student-centered, and targeted (Trilling & Fadel, 2009).

To build on this conclusion, I would argue that in order for student learning to become more personalized and targeted, students will need to build skills of self-awareness and learner capacity; come to see themselves as the designers of their learning contexts and learning environments; build their understanding of the concept that meaning is negotiated and constructed; and participate actively to build the capacity of the learning communities who will support them in meeting their learning goals.

Designed Instruction or Situated Cognition?

It has been argued for some time that a higher education instructor's perspective on how to design effective instruction should be based on learning theory, and a deep understanding of that theory must be undertaken in order to design instruction effectively (Bednar, Cunningham, Duffy, & Perry, 1992). According to Bednar et al., teaching and learning theories emerge from and reflect different epistemological assumptions which collectively form the basis for the theory. The field of instructional design, for example, which has informed understandings of teaching in higher education, initially relied heavily on behaviorist learning theory and cognitive science. This can be seen through elements of instructional design, such as the focus on effective sequencing of behavioral learning outcomes and the search for efficient designs of the learning environments. According to Bednar and her colleagues, the reliance on mapping knowledge or outcomes and measuring them objectively falls under the school of thought called "objectivism" (p. 20). One does not have to look far to see elements of objectivism reflected today in course and program maps and structured and

sequenced learning outcomes. The missing element in designing a course for students in their absence is the student. Instructors need to seek ways to encourage students to set their own learning goals and measure progress within the context of the overall learning objectives of the course or program.

Bednar et al. offer a comparison between instruction based on the objectivist paradigm and the constructivist paradigm. In a constructivist approach, learning is an active process of developing meaning based on experience. The constructivist view is that knowledge is learned best within contexts, such as a real-life (authentic) contexts rather than learning facts in isolation. Students see learning as more relevant if they can see its connection to other problems and other knowledge, which in turn builds complexity. This building of relevance, authenticity, and complexity is referred to as *situated cognition* (Bednar et al., 1992; Lave & Wenger, 1998; Lombardi, 2007). Authenticity can be built into course design through means such as problem-based learning (Barrows & Tamblyn, 1980; Savin-Baden, 2007) and case studies (Gottschlich, 2000; Zuelke & Willerman, 1995) and discussion case studies (Gill, 2011), for example.

In a very similar vein, Lombardi (2007) describes the types of tasks or problems that constitute more authentic types of learning and defines design elements that need to be present, regardless of the subject matter:

- Learning tasks should have real-world relevance and mimic real problems of practice;
- Tasks are often complex, interdisciplinary, and not well-defined;
- Problems are open to multiple approaches and theoretical perspectives; and
- Learning should be complex, requiring reflection, metacognition, and continuous assessment and feedback (Lombardi, 2007).

Savin-Baden (2007) identifies the same elements in problem-based learning (PBL), and here the responsibility is on the students to undertake a series of steps to clarify definitions, define the problem, generate solutions, and report their findings. The role of the instructor in PBL becomes more of a facilitator who not only can help students to focus, but also provides lectures or tutorials as required. She emphasizes, however, that PBL is an approach which is characterized by flexibility as it can be implemented in various ways (Savin-Baden, 2007).

Other aspects of constructivist learning theory in the literature promote situating the learning within the proximal range of the student's

experience and knowledge. Vygotsky (1978) refers to this as the zone of proximal development (ZPD) or the difference between what the student can do unaided versus with support. In other words, the degree of complexity of the problem to be solved should be within the student's reach or within their reach with support (Bednar et al., 1992; Vygotsky, 1978). The role of the teacher changes in a constructivist environment to become more of a coach who models the process of learning, and someone who can also organize and monitor learning. Dewey, who argued that science learning should focus on both knowledge and process, said that teachers should help students learn methods of science inquiry from a young age, and develop these methods throughout schooling (Dewey, 1910).

Students should be encouraged to see that there are multiple perspectives; that problems are seen differently from different vantage points; and that they need to grasp and integrate these alternate views. This process is enhanced through the use of collaborative work groups. In addition, students who construct knowledge for themselves or within their peer group need to understand the processes of thinking, learning, inquiry, and collaboration. The development of these processes should be enhanced through reflection and metacognition.

Research Claims about Active Learning

In this section, selected evidence-based studies related to STEM fields and active learning show that active learning has been researched in STEM classrooms, and the evidence points generally in one direction: there are small but measurable gains shown in multiple studies (Haak, HilleRisLambers, Pitre, & Freeman, 2011; Koohang, Paliszkievicz, Goluchowski, & Nord, 2016; Smith et al., 2009; Smith, Wood, Krauter, & Knight, 2011; Walker, Cotner, Baepler, & Decker, 2008).

Smith et al. (2009) sought evidence about whether peer discussion improved student performance on in-class concept questions in undergraduate biology lectures. Students responded to biology questions using clickers, but had consistently more correct responses when working in groups. Smith et al. investigated whether students were just leaning on the students most likely to have the right answer or if there were gains made from discussing the responses in groups and examining the clicker histogram. They found that peer discussion can be helpful for developing group understanding of biology concepts even when no one in the group knows the correct answer (Smith et al., 2009). Later studies

found that students in the novice and middle range learning groups benefited most from peer discussion plus instructor explanation (Smith et al., 2011) which harkens back to earlier discussions in this chapter about key elements of PBL.

Haak and colleagues claim that the introduction of active learning and culturally responsive teaching have had a “profound effect” on the achievement gap in biology courses (2011, p. 1214). They tackled the issue of the performance and retention of undergraduate biology students from diverse backgrounds in their research and found that a very structured course design combined with active learning reduces the achievement gap. In their case, the active learning in the undergraduate biology class consisted of weekly practice with data analysis, problem-solving, and other higher-order cognitive skills (Haak et al., 2011).

Koohang and colleagues (2016) set out to determine whether or not the stages of guiding learners to become active learners, initiating knowledge construction, and building student ownership of the learning would lead to greater student engagement with the learning material in information technology classes. They found that this was the case: grounding student learning in real-world experiences and using higher-order thinking skills increased student engagement. Similarly, G. Catalano and K. Catalano (1999) found that when they compared the performance of students in student-centered vs. teacher-centered courses in thermodynamics, the students from the student-centered classes showed better progress on standardized tests.

Walker and colleagues (2008), in teaching an introductory Biology class, encountered some of the issues that others have documented with large-class sizes, such as low attendance, low and uneven student engagement, lack of student preparedness, and poor student learning outcomes. As a group, the instructors decided to focus on key understandings rather than “covering” the entire curriculum (p. 362). They broke the class of 500 students into two groups, but changed key elements of the instruction in order to integrate active learning (Table 1).

Walker et al.’s analysis of the distribution of the final grades revealed that students who were lowest in the grade distribution appeared to benefit most from the active learning (Group B in Table 1). What was more surprising was that, in the traditional section, 11 of 240 students had a final grade below 40%; in the active learning section, just one student had a low grade and this student had dropped the course. Students in the traditional section showed higher confidence at the end of the first term, but there were no significant differences in confidence at the end of the full term. Interestingly, the student evaluations for the instructors

Table 1. Different Class Structure for Two Introductory Biology Classes.

Group A: Traditional	Group B: Active
Lecture	Extremely shortened mini-lectures
Unannounced quizzes	Quizzes Wide variety of structured, ungraded, group activities A few graded homework assignments
Multiple choice exams	Multiple choice exams

Source: Developed from Walker et al. (2008).

were “significantly and substantially higher” (p. 364) in the traditional than the active section, which was confirmed in the qualitative data. Students did not warm up to the change in focus from the teacher-centered classroom environment to the student-centered one. This occurred despite the fact that the instructors and TA team were the same for both courses. This finding hints that students can resist active learning and may need time and support to make the change from more passive learning. The overall assessment of the students from the qualitative (focus group) findings was an expressed desire for blending the traditional and active learning formats. In reflecting on the outcomes from this experiment, the Biology instructors had to wrestle with “uncoverage,” meaning that, in the active learning class, they were not able *to cover* all of the content. They found that some of the content could be covered outside of class as assigned readings. They also found that attendance was significantly improved in the active section, reflecting more accountability for attendance in active learning than in the traditional lecture class. As professors they see a gradual evolution from the whole class lecture to the inclusion of more engaging practices (Walker et al., 2008).

Wieman (2007) investigates instruction in physics classes in higher education and suggests the following strategies for STEM instructors:

- Attend to the cognitive load for students using images and explicit organization;
- Address beliefs such as why a topic is worth learning and its real-world relevance;

- Consistently monitor student thinking and homework and provide regular feedback. Make assessments as authentic as possible. Create rigorous means to measure the actual outcomes of higher education instruction;
- Use technology for simulations and to provide opportunities for students to see the lecture material and ask questions online in advance of class to build engagement;
- Organize the learning for the lecture around 7–10 key concepts. Use personal-response systems such as clickers to capture students' understandings (and misconceptions) in a somewhat anonymous way. Use small consensus groups to focus on and discuss responses and come to new understandings (Wieman, 2007).

The topic of the lecture (and the form that it should take) continues to be center stage in discussions about higher education, and this crosses disciplines. One possible framework for reconsidering the lecture is to continue to develop the field of large-class pedagogy, which includes taking a critical look at the benefits and constraints of the large-class lecture. It must be acknowledged that, while there is still great interest in what people have to say (consider, for instance, the uptake on TED talks), there has always been the possibility of a gap between a broadcast of interesting information and how it is processed by the individual learners. As Summerlee (2013) points out, while the lecture is effective for broadcasting information, research indicates that students are challenged to maintain their interest through an hour-long lecture and that lectures promote more superficial levels of learning. He also argues that there are increasing numbers of students in universities who have difficulties processing information and therefore will require more personalized instruction because of this. While these are sufficient reasons to reconsider how the lecture needs to be reshaped for the present generation of students, there is resistance to changing the model of the lecture because it is the forum that academics use to share their ideas and their research. Summerlee notes that, although the evidence of the inefficiency of the large-class lecture has been present since the 1980s, there has been insufficient recognition of this and a lack of change in the academy. He concludes that the weight of the evidence connecting lectures to effective learning means that universities should rethink their approaches to teaching and learning (Summerlee, 2013).

There is also support for more interdisciplinary STEM activities such as sustainable development (e.g., R. Lozano, Lukman, F. Lozano, Huisingsh, & Lambrechts, 2013; Steiner & Posch, 2006). For example,

Williams (2011) in New Zealand finds that there are positive possibilities from STEM integration, including:

- Energizing the learning environment with real-world relevance,
- Igniting learners’ desire to explore and investigate,
- Seeing learners develop confidence and self-direction,
- Building a pathway to technological literacy,
- Encouraging students to think with flexibility and confidence, and
- Reducing the dropout rate (p. 31).

Steiner and Posch (2006) argue that approaches such as transdisciplinary case studies in sustainable development require teachers to abandon their roles as the information providers and students to abandon their roles as consumers of information. What emerges instead is a new learning paradigm focused on “ecological, economic and social development” (p. 878) where each of these three concepts have equal importance. This transdisciplinary learning paradigm is so complex that it cannot be approached by traditional class instruction where knowledge is segmented by discipline. Instead, because of the challenges of the topic and the significance of the conclusions, there is a mutual search for sustainable solutions to the world’s problems. The learning is not focused on gaining factual knowledge but on building capacity to solve complex, authentic problems through planning, decision-making, and project management skills. A key sustainable development skill is self-regulated learning: students are more active than their instructors in seeking information and applying critical thinking in what Steiner and Posch (2006) describe as “mutual self-responsible learning” (p. 881). Unlike PBL where the students work to solve problems, in sustainable development, all of the participants (teacher/researchers, students, and practitioners) seek to build their capacity to solve complex and ill-defined problems.

Boy (2013) reminds us that we are only beginning to understand how the shift from manufacturing to information technologies is changing how we work, learn, and live. He argues eloquently that education systems need to be investigated and updated. The Internet now allows knowledge beyond memory as we can access information literally at the touch of a button (or a voice command). He argues for *understanding* over knowing because the age of the Internet has introduced more complex systems, requiring students to think more critically about the available information. Students, now more than ever, need to be concerned with who is sending the information and if it is supported by respected

institutions. Students also need to understand core concepts of their disciplines and consider how to apply them in real life.

Boy also posits that students need opportunities to embrace and work in the complexity which is the reality of today's existence. Today's issues for scientists, such as sustainable energy, are complex and will require global responses. Students need to know how to be social and how to communicate and they must work creatively and collaboratively to share knowledge in ways that target information differently to different audiences. He finds also that the Internet has had a democratizing effect on education, allowing knowledge to be more accessible to increasing populations (Boy, 2013, p. 7).

To assist in demonstrating how these multiple, different imperatives and suggestions have emerged for improving learning in STEM subjects through active learning approaches, a framework of sample studies and recommendations was created. While this synthesis cannot claim to be definitive, it does provide indications of some of the trends present in STEM higher education today (Table 2).

Reaching Reasoned Conclusions about Active Learning

There has been a steady march over the past several decades toward the democratization of education. Whether or not higher education classes are conducted online, partially online, or in physically co-located settings, instructors must still come to terms with the reality that students have unlimited access to multiple, sometimes competing, sources of information on the Internet. This, alone, does not render the lecture-mode as such obsolete, but it should encourage instructors to question whether or not their role is to select the most important information from a chapter or readings, and talk about it at sufficient length that students will study the topic further.

Access to information does not necessarily equate with the ability to organize and critically analyze information sources so that the knowledge can be applied in other contexts or communicated creatively by students using digital tools. Students are shifting from their role as consumers of information to becoming collaborative learners and the producers of new media. In order for this to happen, students need to construct their own understandings of knowledge so that they become, in essence, knowledge workers. If we want students to be constructors of knowledge and creative communicators, then education has to change to model these approaches through active learning, self-regulation, and

Table 2. Active Learning Framework: Key Elements of a STEM Active Learning Epistemology.

Active Learning Elements	Key Instructional Imperatives
Student-centered focus	<p>Students as active learners (Freire, 1970; Wieman, 2007)</p> <p>Personalized education (Freire, 1970; Hornsby & Osman, 2014; Pellegrino, 2006; Summerlee, 2013)</p> <p>Student voice (Freire, 1970)</p> <p>Students are producers of their education (Jourdan et al., 2004)</p> <p>Build new learning on the prior learning of the individual (Chickering & Kuh, 2005; Wieman, 2007)</p> <p>Student ownership of the learning (Bransford et al., 2002; Chickering & Kuh, 2005; Koohang et al., 2016; Steiner & Posch, 2006)</p> <p>Safety in learning (Biggs, 1999; G. Catalano & K. Catalano, 1999)</p> <p>Construction of meaning through active engagement (Wieman, 2007)</p> <p>People learn by creating their own understanding (Wieman, 2007)</p>
Authentic (messy, complex) tasks	<p>Higher-order thinking skills (Bloom, 1956; G. Catalano & K. Catalano, 1999)</p> <p>Meaningful, relevant learning (Prince, 2004)</p> <p>Authentic tasks (Koohang et al., 2016; Wieman, 2007)</p> <p>Build relevance, authenticity, and complexity into work in classrooms (situated cognition) (e.g., Bednar et al., 1992; Koohang et al., 2016; Lave & Wenger, 1998; Lombardi, 2007)</p> <p>Problems should have real-world relevance and require sustained investigation (Lombardi, 2007)</p>

Table 2. (Continued)

Active Learning Elements	Key Instructional Imperatives
Innovation skills/Career focus	Ability to learn on the job (Cukier, 2016) Adaptive expertise (Pellegrino, 2006) Flexibility, adaptability, initiative, self-direction (Trilling & Fadel, 2009) Work skills, e.g., productivity (Trilling & Fadel, 2009)
More diverse instructional approaches	Employ more diverse instructional approaches, larger repertoire (Chickering & Kuh, 2005; Pellegrino, 2006) Uncover students' misconceptions in order to build on them (Pellegrino, 2006; Wieman, 2007) Increase retention by moving from the lecture to more engaged types of learning (Wieman, 2007) Case studies (Gottschlich, 2000; Zuelke & Willerman, 1995) Culturally responsive teaching (Haak et al., 2011) Clickers or personal-response systems and consensus groups to discuss the responses (Smith et al., 2009, 2011; Wieman, 2007) Discussion case studies (Gill, 2011) Model how to organize learning (G. Catalano & K. Catalano, 1999; Pellegrino, 2006) Model the use of technology applications that students employ in their out-of-school online learning (Jacobsen & Lock, 2004; Voogt, Erstad, Dede, & Mishra, 2013) Organize the lecture around 7–10 key concepts (Wieman, 2007) Problem-based learning (Barrows & Tamblyn, 1980; Pellegrino, 2006; Prince, 2004; Savin-Baden, 2007)

Table 2. (Continued)

Active Learning Elements	Key Instructional Imperatives
	<p>Problem and project-based learning activities (Haak et al., 2011; Lombardi, 2007; Pellegrino, 2006; Prince, 2004)</p> <p>Transdisciplinary case studies (sustainable development) (Lozano et al., 2013; Steiner & Posch, 2006; Williams, 2011)</p> <p>Uncoverage: some content covered out of class (Walker et al., 2008)</p>
<p>Communication skills/ ICT skills</p>	<p>Communication skills (Prince, 2004)</p> <p>Digital literacy skills (Pellegrino, 2006; Trilling & Fadel, 2009)</p> <p>Social and cross-cultural skills (Trilling & Fadel, 2009)</p>
<p>Concept mapping, models</p>	<p>Situated learning; communities of practice (Lave & Wenger, 1998)</p> <p>Collaboration with peers (Biggs, 1999)</p> <p>Teamwork and knowledge work for the global digital era (Olson, 2015)</p>
<p>Digital literacy skills: information literacy, media literacy, ITC literacy</p>	<p>Students need assistance and models to organize learning: find patterns, build models of learning and conceptual frameworks to help them with knowledge retrieval (G. Catalano & K. Catalano, 1999; Pellegrino, 2006; Wieman, 2007)</p>
	<p>Students need to learn how to approach cognitive dissonance (Pellegrino, 2006)</p> <p>Instructors should scaffold the task (Koochang et al., 2016)</p> <p>Students should encounter multiple perspectives and a variety of resources in order to discern the relevant information (Bednar et al., 1992; Lombardi, 2007)</p> <p>Learn how to determine an expert view (Dede, 2008)</p>

Table 2. (Continued)

Active Learning Elements	Key Instructional Imperatives
Complexity	Conscious awareness of the sources of messages, their quality, and consequences of attending to them (Flavell, 1979)
	Use technology to support communication and learning (Dede, 2008; Garrison et al., 2001; Jacobsen & Lock, 2004; Lombardi, 2007; Pellegrino, 2006)
	ITC literacy (Cukier, 2016; Trilling & Fadel, 2009)
	Conscious awareness of sources of information and consequences of attending to each (Flavell, 1979)
	Ethical complexity (Fuchs, 2011) Help students gain the skills of inquiry learning (Lombardi, 2007; Pellegrino, 2006) Encourage higher-order thinking (Bloom, 1956; G. Catalano & K. Catalano, 1999; Koohang et al., 2016).
Collaborative learning, co-operative learning, positive interdependence	Problems should be complex, require sustained investigation and collaboration (Lombardi, 2007)
	Encourage collaborative and co-operative learning – opportunities for productive group work (Bednar et al., 1992; Biggs, 1999; G. Catalano & K. Catalano, 1999)
	Positive interdependence (D. Johnson & R. Johnson, 2009; Johnson et al., 1984).
	Mutual, self-responsible learning (Steiner & Posch, 2006)
Metacognition/ Monitoring own learning	Metacognition includes knowledge of one's capacity and how one (self) learns, reflections on past learning, conscious awareness of understanding or lack of, setting learning goals (Flavell, 1979)

Table 2. (Continued)

Active Learning Elements	Key Instructional Imperatives	
	Clarity around learning objectives (Biggs, 1999; Bransford et al., 2002)	
	Build skills of metacognition (Bednar et al., 1992; Bransford et al., 2002; Lombardi, 2007; Pellegrino, 2006; Prince, 2004)	
	Make thinking visible (Pellegrino, 2006)	
	Develop metacognitive skills through peer collaboration (Wieman, 2007)	
	Students need to know how learning happens, including their own learning (Trilling & Fadel, 2009)	
	Realistic self-assessment (Cukier, 2016)	
	Self-regulated learning, mutual self-responsible learning (Steiner & Posch, 2006)	
	Alignment between learning and assessment	Ensure transparency and alignment among the learning objectives, learning plan, and assessments (Biggs, 1999)
	Continuous, personalized feedback, assessment to inform instruction	Critical forms of assessment including peer assessment and self-assessment (Wiggins & McTighe, 2005)
		Assessment should be continuous through carefully designed homework, grading policies, and feedback (Lombardi, 2007; Wieman, 2007)
	Assessment should inform the teachers about student learning so that they can give better feedback to teachers (Pellegrino, 2006)	
	Monitor student attainment of key concepts (Wieman, 2007)	
	Provide prompt, detailed, and personalized feedback (Chickering & Kuh, 2005)	

metacognition. Both instructors and students need to embrace these new realities. As more students enroll in higher education, instructors will become more responsive to increasing student diversity. Students will also need to be more responsive to diverse perspectives and acknowledge that there may be more than one right answer.

In reviewing the present trend toward what she terms as “consumerism” in higher education, Regan (2012) wrestles with the functional and moral roles of instructors and students. She concludes that the *role of the instructors is to use their abilities to facilitate optimal learning*. In turn, the role of the students should be to *do their best to learn* (Regan, 2012). To this I would add that, in order to preserve what is best in humanity and meet the needs of future generations, today’s students need to embrace the complex nature of problem-solving and decision-making and view higher education as an opportunity *to learn how to learn*. Active learning engages them in this process.

References

- Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education*. New York, NY: Springer Publishing Company.
- Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link. *Constructivism and the technology of instruction: A conversation*, 17–34.
- Biggs, J. (1999). What the student does: Teaching for enhanced learning. *Higher Education Research & Development*, 18(1), 57–75.
- Bloom, B. S. (1956). *Taxonomy of educational objectives. Vol. 1: Cognitive domain* (pp. 20–24). New York, NY: McKay.
- Boy, G. A. (2013). From STEM to STEAM: Toward a human-centred education, creativity & learning thinking. *Proceedings of the 31st European Conference on Cognitive Ergonomics* (p. 3). ACM.
- Bransford, J., Vye, N., & Bateman, H. (2002). Creating high-quality learning environments: Guidelines from research on how people learn. In *The Knowledge Economy and Postsecondary Education: Report of a Workshop* (pp. 159–198). Washington, D.C.: National Academy Press.
- Catalano, G. D., & Catalano, K. (1999). Transformation: From teacher-centered to student-centered engineering education. *Journal of Engineering Education*, 88(1), 59–64.
- Chickering, A. W., & Kuh, G. D. (2005). *Promoting student success: Creating conditions so every student can learn* (Occasional Paper No. 3). Bloomington, IN: Indiana University Center for Postsecondary Research.
- Cukier, W. (2016). Bridging the skills gap. Retrieved from <http://www.hrpatoday.ca/article/bridging-the-skills-gap.html>
- Dede, C. (2008). A seismic shift in epistemology. *EDUCAUSE review*, 43(3), 80.

- Dewey, J. (1910). Science as subject-matter and as method. *Science*, 31(787), 121–127. Retrieved from <http://www.jstor.org/stable/1634781>
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American psychologist*, 34(10), 906.
- Freire, P. (1970). *Pedagogy of the oppressed*. New York, NY: Herder & Herder.
- Fuchs, C. (2011). WikiLeaks: Power 2.0? Surveillance 2.0? Criticism 2.0? Alternative media 2.0? A political-economic analysis. *Global Media Journal: Australian Edition*, 5(1), 1–17.
- Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of distance education*, 15(1), 7–23.
- Gill, T. G. (2011). What is a discussion case? Retrieved from <http://mumacasereview.org/what-is-a-discussion-case>
- Gottschlich, M. (2000). Writing basics: Elements of the case study. *Journal of the American Dietetic Association*, 100(11), 1293–1295.
- Haak, D. C., HilleRisLambers, J., Pitre, E., & Freeman, S. (2011). Increased structure and active learning reduce the achievement gap in introductory biology. *Science*, 332(6034), 1213–1216.
- Hornsby, D. J., & Osman, R. (2014). Massification in higher education: Large classes and student learning. *Higher Education*, 67(6), 711–719.
- Jacobsen, D. M., & Lock, J. V. (2004). Technology and teacher education for a knowledge era: Mentoring for student futures, not our past. *Journal of Technology and Teacher Education*, 12(1), 75.
- Johnson, D. W., Johnson, R., Holubec, E., & Roy, P. (1984). *Circles of learning. Cooperation in the classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher*, 38(5), 365–379.
- Jourdan Jr, L. F., Haberland, C., & Deis, M. H. (2004). Quality in higher education: The student's role. *Academy of Educational Leadership Journal*, 8(2), 17.
- Koohang, A., Paliszkievicz, J., Goluchowski, J., & Nord, J. H. (2016). Active learning for knowledge construction in e-learning: A replication study. *The Journal of Computer Information Systems*, 56(3), 238–243.
- Lave, J., & Wenger, E. (1998, 2008). Communities of practice. Retrieved from <http://www.valenciacollege.edu/communities>
- Lombardi, M. M. (2007). Authentic learning for the 21st century: An overview. *Educause Learning Initiative*, 1(2007), 1–12.
- Lozano, R., Lukman, R., Lozano, F. J., Huisingsh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: Becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, 48, 10–19.
- Olson, M. P. (2015). A multilateral approach to bridging the global skills gap. Retrieved from <http://www.cornellhrreview.org/a-multilateral-approach-to-bridging-the-global-skills-gap/>

- Pellegrino, J. W. (2006). *Rethinking and redesigning curriculum, instruction and assessment: What contemporary research and theory suggests*. National Center of Education and the Economy for the new commission on the skills of the American workforce. NCEE. Retrieved from <http://www.skillscommission.org/>
- Prince, M. (2004). Does active learning work? A review of the research. *Journal of engineering education*, 93(3), 223–231.
- Regan, J.-A. (2012). The role obligations of students and lecturers in higher education. *Journal of Philosophy Education*, 46, 14–24. doi:10.1111/j.1467-9752.2011.00834.x
- Savin-Baden, M. (2007). *A practical guide to problem-based learning online*. New York, NY: Routledge.
- Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., ... Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. *Science*, 323(5910), 122–124.
- Smith, M. K., Wood, W. B., Krauter, K., & Knight, J. K. (2011). Combining peer discussion with instructor explanation increases student learning from in-class concept questions. *CBE-Life Sciences Education*, 10(1), 55–63.
- Steiner, G., & Posch, A. (2006). Higher education for sustainability by means of transdisciplinary case studies: An innovative approach for solving complex, real-world problems. *Journal of Cleaner Production*, 14(9), 877–890.
- Summerlee, A. (2013). Lectures: Do we need them at all? In D. J. Hornsby, R. Osman, & J. De Matos-Ala, *Large-class pedagogy: Interdisciplinary perspectives for quality higher education* (pp. 21–31). Stellenbosch, South Africa: African Sun Media.
- Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco, CA: John Wiley & Sons.
- Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning*, 29(5), 403–413. Retrieved from <http://ai2-s2-pdfs.s3.amazonaws.com/5113/5f0cd1fad2cfe00b26c531ccfd8bbc4a1280.pdf>
- Vygotsky, L. (1978). Interaction between learning and development. *Mind and society* (pp. 79–91). Cambridge, MA: Harvard University Press.
- Walker, J. D., Cotner, S. H., Baepler, P. M., & Decker, M. D. (2008). A delicate balance: Integrating active learning into a large lecture course. *CBE-Life Sciences Education*, 7(4), 361–367.
- Wieman, C. (2007). Why not try a scientific approach to science education? *Change: The Magazine of Higher Learning*, 39(5), 9–15.
- Wiggins, G. P., & McTighe, J. (2005). *Understanding by design*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Williams, J. (2011). STEM education: Proceed with caution. *Design and Technology Education: An International Journal*, 16(1).
- Zuelke, D. C., & Willerman, M. (1995). The case study approach to teaching in education administration and supervision preparation programs. *Education*, 115(4), 604–612.