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Edited by Olena Lutsenko and Gregory Lutsenko

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Published in London, United Kingdom







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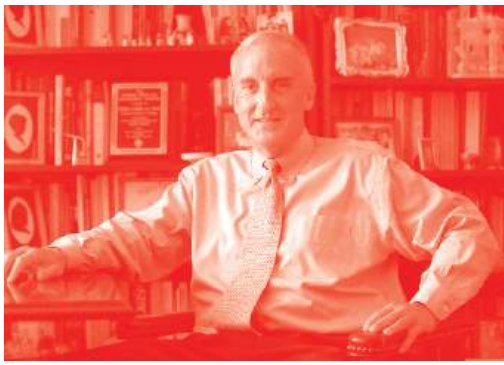

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http://dx.doi.org/10.5772/intechopen.87353
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First published in London, United Kingdom, 2022 by IntechOpen
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 5 Princes Gate Court, London, SW7 2QJ, United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Active Learning - Theory and Practice
Edited by Olena Lutsenko and Gregory Lutsenko
p. cm.
Print ISBN 978-1-83968-473-9
Online ISBN 978-1-83968-477-7
eBook (PDF) ISBN 978-1-83968-478-4

Meet the editors

Olena Lutsenko obtained her Ph.D. in 2021. Since 2015, she has had the opportunity to work on a departmental research topic on the fundamentalization of natural education for sustainable development. She is currently working on scientific topics at Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Ukraine, and teaches medical and biological disciplines and features of teaching methods of these disciplines. She has published more than seventy-nine scientific papers, including five textbooks and five monographs. Her recent research focuses on the peculiarities of preparing future teachers for their professional activities, as well as on the introduction of modern educational technologies in educational activities.

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Contents

Preface

Nowadays, critical thinking and decision-making skills are paramount, as people are often confronted with outdated approaches, injustices, and conservatism in addressing many important issues. People need to be able to stand for positive change. The educational process plays a significant role in the formation of personality characteristics. It is in the process of learning that self-esteem, tolerance, independence, responsibility, and the ability to discuss and defend one's beliefs develop. Thus, how we teach is just as important as why we teach. With the help of teaching methods like active learning, one can simulate behavior aimed at advocating for change.

Numerous studies show that teaching children and adults is more effective and more enjoyable when it is active. Democratic education helps students to improve and systematize their knowledge and skills, activate their own experience, and develop thinking, memory, attention, imagination, and a positive attitude about the learning process.

In a person-centered team, teachers constantly make decisions, work with other adults and children to create a developmental environment, respect children's opinions and choices, and enable children to develop the skills that will be the foundation of their future success.

The use of active learning methods is extremely important because they have a great impact on students, their acquisition of knowledge, and the development of personal qualities. Some studies show that adult learners prefer active learning methods as well. Others emphasize that in terms of assessing active learning methods and traditional lectures, the success rates of students' learning are commensurate, but the rates of mastering new skills are much greater than those achieved after a course of regular lectures. Studies have also shown that a significant number of adults with different individual learning styles learn more effectively using active learning methods. For teachers, how much a person knows is important, but so is how much they have learned while learning and how they will use the knowledge gained. Thus, a thoughtful approach to the use of active learning methods includes engaging students and teachers in the practice of self-reflection and understanding how adult learners learn most effectively.

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Chapter 1

Features of Management of Research Activity in Higher Educational Institutions

Gregory Lutsenko and Olena Lutsenko

Abstract

Modern pedagogical science and practice seek to comprehend the holistic pedagogical process from the standpoint of management science, to give it a clear scientifically sound character. The statement of many domestic and foreign researchers that management is real and necessary not only in the field of technical, production processes but also in the field of complex social systems, including pedagogical, is true. The introduction of innovation management is important for successful research at the university. Therefore, the main **idea/goal** of our study is to develop the concept of innovation as new ideas and knowledge (radical and those that improve the result), mechanisms for their practical implementation, and, most importantly, mechanisms for the dissemination of innovations. On the one hand, in many countries there are tendencies to create largely, often international clusters of research work, on the other - now in the staff of universities are introduced positions of research management specialists in existing projects and centers. Unlike pure administration, innovation research managers must make decisions based on scientific knowledge and information about society as a whole. Some authors note a growing similarity between non-university research centers, industrial laboratories, and classical universities. In fact, scientists from industrial and large research organizations have greater autonomy, for example, there are optimal conditions for creative research (at the university it is combined with the educational process). Large joint projects and the commercialization of research results in many disciplines represent this trend. The main **methodology** of our study was methods of theoretical and empirical nature. In the process of researching the problem outlined by us, we found that thus, it is established that the introduction of a system of information management of research activities in higher education, in general, contributed to the growth of performance management of research activities and improve the level of training of future professionals. Therefore, we dedicate our research to the peculiarities of educational management in educational institutions of Ukraine.

Keywords: management, management of educational institution, innovations, administration, projects

1. Introduction

The accumulation of financial, cognitive and instrumental means allows to ensure a higher degree of division of labor during research. For large research projects, the involvement of engineers, technicians, managers, specialists in the field

of information and computer technology, ie the construction of a new structure of organizational and functional division of labor is inevitable. Thus, systematic planning reaches a higher degree of formalization [1, 2].

In the scientific literature on the management of scientific activity, two terms are used, which have a slightly different meaning - "management" and "management". More general, in our opinion, is the term "management", but "management approach" reflects important aspects of the same topic. The management of scientific activity is divided into a large number of practically independent entities located at different levels of the hierarchy within research organizations, and not only at the management level of the research system [3, 4]. Therefore, it is worth focusing on management as a decision-making process that is imposed on specific organizational and cognitive contexts. Management research is a day-to-day activity that takes into account the complex and ever-changing institutional environment of research in order to enable successful and productive research. Such an environment is characterized by competition and cooperation of entities that have different, sometimes conflicting goals and different access to the resources of the organization, government and assets. Sometimes research management is associated only with reforms of individual university administration positions, although in many other cases the set of skills necessary for successful research management is determined [5]. The need to manage research is due to at least three interrelated factors. First, an increasing number of research organizations compete with each other to obtain resources from governments and the private sector. Second, complex scientific problems require transdisciplinary collaboration within research institutes or between them and non-scientific organizations [6]. Third, many industries depend on expensive infrastructures, equipment, and devices (such as particle accelerators, gene synthesizers, supercomputers, or even satellites) that require government support and inter-agency cooperation.

The growing demand for social support for research has created new opportunities for politicians to conduct social research programs [6, 7]. Funding for grant programs is increasingly combined with external non-scientific goals, such as increasing international competitiveness, solving urgent social problems [8, 9]. Scientists should take into account new external influences on research objectives and their evaluations and structure, respectively.

In the general analytical basis, scientists distinguish three levels of research of the management system of scientific activity: the level of the state, the strategic level and the level of implementation, or operational level [10].

The analysis shows that conducting large-scale research on national systems of organization of scientific activity helps to establish national priorities and development strategies of scientific institutions. However, such studies do not provide answers to the specific mechanisms of functioning of scientific institutions. Unlike previous large-scale research, modern researchers are working on the development of specific technologies, new programs, which are often required by scientists themselves in order to justify the usefulness of their activities [7, 11].

Basic research programs are still the main ones, although their financial support has slightly decreased compared to applied and problem-oriented research. However, expanding cooperation with firms and external stakeholders is not only an empirical observation [12], but also an important state goal. Discursive concepts such as "transdisciplinarity", "relevance" or "competitiveness" are among the new goals of the study. Management of strategic cooperation provides an opportunity to achieve them [8, 13].

The next aspect of research management can be defined at the level of funding of institutions. Managers' actions not only turn existing unresolved scientific problems into promising research, but managers are also intermediaries who actively monitor scientific developments and try to integrate innovative research areas.

The third level of management is the management of research organizations, such as universities or consortia of higher education [14]. Nowadays, university administrations, as a rule, promote the introduction of management control systems that are similar to those existing in business organizations [15]. They are characterized by formalized control and evaluation procedures to increase the productivity and responsibility of scientists for the use of resources and results of scientific activities. One of the risks is that university leaders are beginning to give preference to more productive industries and, consequently, increase domestic funding for these areas of research.

Finally, the last level is project management in research groups, research clusters, research centers and departments, where research is actually carried out. In such groups, decisions are made taking into account the cognitive dynamics of the scientific field.

Due to the great need for resources and the growing complexity of the extensive structure of research institutions of various scales, the organization of research projects is extremely time consuming. One of the consequences is the emergence of specialized links between organizations, a kind of bridge between different branches of science and the application of new scientific knowledge. Prominent examples of this are the transfer of technology or other information between departments in universities. All research structures perform integrative functions in the sense that they regulate the relationship between science and society. It is much easier for organizations to mobilize resources for research. In fact, modern research is virtually impossible outside of formal organizations. They provide the legal framework and legitimacy, and scholars are hired and paid for by certain organizational structures.

However, the management of research is not limited to the work of establishing links within one organization or between several different ones. Some actions of a complex management complex require the performance of non-traditional functions for scientists. Accordingly, the management of research projects requires well-trained managers who clearly understand both the specifics of creative research and have the ability to solve practical organizational problems.

Management of research work is an activity performed at the intersection of science and public interests [16–18]. The term "boundary work" was first used as an alternative to the logical criterion for demarcating scientific and non-scientific concepts. It should be noted that in this case, such a term does not mean the isolation of scientific activity, but, on the contrary, makes it possible to ensure contact, to maintain control over complex research in such an environment [19, 20]. Indeed, the organization of research projects is an extremely time-consuming activity. This is due to the huge need for resources and the complexity of the structure of scientific institutions. In such conditions, research structures must regulate the relationship between science and society. With the help of such structures it is much easier to mobilize the resources needed to conduct research.

Of course, scientists, consciously or not, but always engaged in "work at the border." Such activity, in particular, was conditioned by the norms of scientific communication, when scientists had to bring the input research data, experimental data or working records to a unified form [21, 22]. Scientists are usually members of committees, expert councils, responsible for the redistribution of funds allocated by the state, international or private funds for research.

However, the management of research activities is not limited to such activities, as the structural links between science and society are increasingly difficult to unify and formalize [23, 24]. No organization can focus only on scientific issues. There are departments responsible for human resources, public relations, planning, legal issues, intellectual property issues.

The university is an example of how to find a compromise between different objects of the management process in the organization of research activities. On the one hand, of course, the university administration is trying to gain more control over research. At the same time, some scientists (research groups) maintain their own external relations with financial institutions, partner organizations, etc. This state of affairs reflects situations where tensions may arise between different sectors, which need to be mitigated by modern management methods.

Management of scientific activity belongs to the processes related to both scientific dynamics (knowledge production) and social (introduction of scientific knowledge into practice). Thus, the boundary between the administrative and scientific spheres is quite blurred. The ultimate goal of research management is to produce selective links between certain organizational elements. The question of the mechanisms of formation of such connections remains open. Nowadays, we can observe a great variety of management mechanisms, as research contexts have become more diverse [12]. Concentration of some distributed management tasks within specialized management positions could contribute to the development of new professional roles.

The place and role of higher education institutions in the scientific sphere. Higher education has always been considered in the light of its fundamental contribution to the social, cultural and intellectual life of society, which is carried out by increasing human capital. In recent years, competition between countries to grow their role in the global economic space has forced governments to think more strategically about the economic value of knowledge production and dissemination.

The governments of the leading states are currently reviewing the structure of the higher education system, organizational superstructures and mechanisms for their financing. The attention of government agencies is focused on the allocation of resources for research and development, on the formation of human capital through education and specialized vocational training, knowledge management and the organization of relevant institutions. In turn, the status and prestige of research institutions is determined by the quality and scope of research. The quality of research is reflected as a place in the ranking, which is occupied by research groups and the university in general. The volume of research is related to economic factors, which are reflected in the direct profits of the institution and in the profits from innovative ideas. Universities are looking for ways to reorganize optimally to address the challenges they face.

A common requirement for all universities is to increase academic productivity within the available financial capacity and increasingly accountable. Many universities were initially established in response to initiatives related to the mass and democratization of higher education, the needs of the labor market and other socio-economic factors. In recent years, innovations in education and professionalization of disciplines have forced the university to offer postdoctoral programs and strengthen its own research capacity. Today, universities offer comprehensive higher education, supported by growing experience in research, development and consulting.

Governments respond to the needs of the time in different ways: some create unified university systems. At a time when others choose to maintain the distribution of universities by type as a key policy that determines the differentiation of research areas and diversification of sources of financial support. Universities position the need to strengthen scientific capacity and capacity as the basis for their functioning and survival. Accordingly, all universities are engaged in the development of research strategies to increase research activity and organizational support and management of research structures within the university.

At present, research activities can bring significant financial benefits for both scientists and their institutions. This is reflected in the activities to determine institutional priorities, the creation of research units, the emphasis on the work of permanent research groups working within specialized units (centers), in cooperation with other institutions or organizations.

Taking into account the scientific and pedagogical orientation and analysis of the teaching staff, modern universities carry out traditional academic research (fundamental, applied or strategic); organize the transfer of knowledge and technology. With some exceptions, the research priorities of higher education institutions reflect the national priorities and criteria of donor financial institutions. Each institution develops its own concept of development of scientific and educational process on a scale from extremely scientific-oriented to extremely pedagogical-oriented activity.

Successful research is associated with certain difficulties. Financial support provided to universities by public institutions or public foundations is often determined by non-scientific considerations (historical conditions, traditions, established contacts), or by a limited number of universities and traditional research institutes. Without alternative sources of funding and increased autonomy, it is difficult for universities to quickly reshape their research to meet the requirements of donors.

Identifying priority areas for research and research on funding allocation models is an important and urgent task. Universities are developing development strategies related to human resources as a key component of the scientific field. With some exceptions, universities do not want to be transformed into knowledge-intensive institutions, but are forced to intensify research. Analysis of the scientific literature allows us to identify the following strategies of the university:

- investment-oriented strategies and budget restructuring;
- creation of new organizational structures, in particular new postgraduate courses;
- creation of independent commissions to identify and support the most competitive at the international, national, regional level research groups and projects;
- organization of research clusters and centers of interdisciplinary research to optimize external funding;
- distribution of resources and needs in accordance with the built scale of priority research;
- creation of strategic alliances with other universities, research centers, industrial enterprises, etc.;
- active cooperation with relevant ministries, sponsorship organizations, etc.;
- finding funds to establish additional scholarships and grants.
- The tasks facing the university under such conditions are:
- expanding access to knowledge (in fact, the formation of a knowledge society);

- overcoming the difficulties caused by the so-called "late start" (which is extremely important for the system of Ukrainian higher education) - obtaining grants to create and improve infrastructure, such as laboratories, libraries, etc.;

- providing funding not only for applied but also for basic research under agreements between the government and universities from various sources, identifying and promoting research at all levels - from students to full-scale research groups.

Mechanisms of formation of priorities of research activity. Global changes and diversification processes are forcing universities to reassess their capabilities in order to find competitive resources. At the same time, research is actively developing, becoming more complex and needs, above all, financial support to ensure quality results. Obviously, public funding in such a situation is only one source of support for research disciplines. Therefore, most universities are beginning to change the organizational and managerial aspects of research. One of the ambiguous consequences of such societal demands is the fact that universities choose as the goal of strategic development activities that will bring the maximum funds, rather than just activities that they can best implement under the existing conditions. A strategy focused on a radical change of priorities is not always the most promising. Most universities have a well-established tradition, history, specialization and, as a rule, limited resources. Thus, the priority should be the optimal use of scarce resources (financial, human and material) by finding a balance between the university's reserves and the needs of the environment. Priorities must be determined not only by current strengths but also by future potential. Plans for research should be long-term.

The characteristics of the project activity are the focus on the implementation of the defined goal, the need for coordination measures (events and project participants), the need to take into account the limited resources (time, labor, material resources) and the uniqueness of each project [22]. When research activities are established in the university, the management activities are mainly coordination. However, the objects of management in this segment (vice-rector for research, head of research, directors of institutes, etc.) must be the concentrators of innovative ideas and generate their implementation.

In general, the task of project management is to achieve the set goals in terms of volume, time, cost and quality. Setting priorities is an important step in the presented scheme. In our opinion, setting priorities is a fundamental task for building the future, not for monitoring it. Higher education institutions will constantly take care to expand the list of areas of research. The process of setting priorities for higher education is considered a necessary and mandatory practice. It pushes higher education institutions to make difficult choices between external, university and research priorities. Ideally, the priority plans for the long-term development of the university should be developed as a superposition of all three priorities. However, the reduction of public funding, the identification of national priorities force the university management to focus on the latter two. In addition, the survival of the educational institution and the preservation of its status become essentially inseparable processes (competitive positioning significantly affects the priorities of the university).

For many universities, this means focusing on applied, interdisciplinary research that is strongly linked to regional interests, and on developing it by attracting innovative grants and commercializing research.

The main criterion for selecting priorities is the urgency and importance of research areas and the social response to their results. General management is conditioned by general guidelines for matching researchers' needs with educational

needs. All priorities are built in accordance with the indicators of research effectiveness, and the concept of effectiveness can and should be discussed.

Another important factor influencing the choice of priorities in universities (and, consequently, funding schemes, organizational structure, planning processes and personnel strategy) is the time that universities can devote to building research capacity. This problem is due to the multifaceted nature of the challenges facing the university. In particular, the integration of research and teaching is a fundamental task of the university. However, researchers (research and teaching staff) are dissatisfied with the fact that their workload absorbs the time needed for research; successful researchers sometimes neglect their educational responsibilities, etc. [11, 25].

Let us define the basic directions of researches which can be realized on the basis of universities, and their characteristic features.

As we can see, the main sources of funding for science are external to the university (public funds, regional projects, orders from industry, private funds, etc.).

At the internal level, the structure of the organization of scientific activity is similar for all universities. The position of deputy head (vice-rector) for scientific issues is practically obligatory, and his responsibilities include the management, organization and implementation of competitive research methods. The formulation of a research strategy is a benchmark on the basis of which each unit identifies a number of priority studies or interdisciplinary topics. Depending on the structure and specialization, the university administration acts as a coordinator and helps to build links between faculties and individual research groups, working with deans or project managers.

Units are required to explain the process by which priorities were set, who is involved in the research, and the expected consequences. In this case, informal or informal factors that may affect the research process should also be considered.

All sources of funding can be divided into three groups. The first of these is centralized financing (financing from above). At the same time, priorities and own funding can be distributed by the management, in accordance with the urgent needs and the current state of the university. The second group includes decentralized funding (bottom-up funding), which actually reflects the real state and capacity of individual research groups. This type of funding should include grants, projects, etc. And the third group, which is the most common, involves combined funding (for example, raising funds, on the one hand, and experimental capacity, on the other).

In any case, a mechanism for coordinating actions with the involvement of all units is mandatory. Strictly centralized mechanism operates in the interests of the whole university and allows not to lose individual research units, which at a certain stage of work do not form a request for centralized funding and do not perform research. Numerous ways to implement such a mechanism include research committees (scientific council, scientific council) or management committees. The creation of centralized mechanisms for setting priorities does not have a clear positive response from scientific groups, but such an approach has a right to exist. The regulatory mechanism for its application should be a clear provision defining the rights and powers of all committees and individual representatives. In terms of active external funding, cooperation with partners outside the university comes to the fore.

Information-analytical system "Science" based on web-technologies is an example of innovative management of research activities in an educational institution.

Scientific activity is the most important component of the work of the university as a whole, as well as its individual departments and staff. According to the intensity and effectiveness of scientific activity, the presence of an innovative component in it, we can say how the higher education institution corresponds to the status of the university.

Solving the problems of innovation economy development requires a significant deepening of knowledge about high, science-intensive and information technologies; management of intellectual potential of personnel, economic essence of intellectual capital, features of its formation and use, and also tools and methods of effective management of innovative processes. Therefore, the question of the effectiveness of research management, the need to develop special management tools and methods that would form effective organizational and economic mechanisms for the accumulation and expansion of scientific knowledge, introduced into domestic science-intensive enterprises.

Systematic research of the process of formation, accumulation, effective use and commercialization of scientific activity is becoming increasingly important today, especially for knowledge-intensive enterprises, especially those related to the reform of the national economy.

In analyzing the problem of research management, much attention is paid to the approaches to the organization and classification of sciences, research and selection of their stages [26]. However, despite the significant number of works performed, theoretical, methodological and methodological aspects of the research management process are not sufficiently disclosed. Let us dwell on this in more detail.

At the beginning of the XX century. P. Freeman formulated a hypothesis about the feasibility of describing the process of conducting research on the management process [26]. But in the currently developed concepts of management of scientific activity consider only its separate spheres that does not allow to form the general theoretical base. The lack of purposeful integration of all components of the management system of scientific activity and the orientation of all structures of the scientific organization to achieve the set goals prevents the effective transformation of employees' knowledge into profitable assets.

Successful implementation of the tasks of managing the scientific activity of educational institutions allows to increase the level of scientific and educational potential and financial independence of universities, to ensure close integration of business and education. Modern software and methodological solutions allow you to effectively implement these tasks. However, the analysis of the current practice of using information systems in this area shows that none of the technologies provides the following tasks:

1. increase the transparency and relevance of data;

2. providing access to scientific personnel to the relevant information within a single information system;

3. increase the efficiency of preparation of current and final reports on research activities;

4. operational control over the implementation of current research projects and other tasks.

As modern business and production are inconceivable without the automation of their business processes, so the modern process of scientific research cannot exist without the use of new information technologies and project management techniques. Modern innovative science can be considered as a business that implements a set of business processes. And so naturally there is a need to describe business processes, research processes, etc.

We have previously considered the existing problems of project management in various fields, including in the process of scientific research. Proven fact is

the effectiveness of project management in solving engineering problems. This approach has shown in practice its advantage over network or calendar planning methods. In our opinion, the application of the project approach in research will also be effective. But for this purpose it is necessary to develop methods and on their basis - the corresponding tools, considering rules and the accepted standards in the field of project management and in scientific activity of high school.

Unlike the engineering industry, where all stages can be described and the results of intermediate stages known in advance, in activities such as research and implementation of intellectual property results, it is not possible to predict all expected results in advance. In the best case, you can know exactly what is coming in and what the end result should be. All intermediate stages will be adjusted taking into account the results achieved in the previous stages of the study. This is the main difference in the use of classical methods and tools of the design approach (in the field of engineering) in relation to the research process.

The process of research management is characterized by two main aspects - methodological and informational. Modern development of methods and mechanisms of project management in various subject areas and improvement of information technologies allows to introduce methods of project management in universities to support research. But since the application of standard methods and tools does not take into account the specifics of research in higher education, their direct use is impossible.

Currently, one of the effective management tools is information-analytical systems (IAS). IAS support of scientific activity, which is part of the corporate information environment of the university, is a perfect management tool, as it is able to operate huge arrays of information related to the object of management, integrate information and analytical support of scientific activity with support of other university activities. Educational, etc.

When building a model of information management system for the organization of scientific activities of a classical university, the object of management is scientific activity. As a mechanism for managing scientific activities, it is proposed to use IAS using modern web-solutions.

Based on the historically formed traditional notion and legally established interpretation, we state that the classical university differs from other types of educational institutions:

- a wide range of areas of training, retraining and advanced training of specialists, bachelors, masters and graduate students in educational programs of higher, postgraduate and additional professional education;

- a wide range of areas of research in which basic research and applied development.

Only classical universities combine traditionally university natural sciences, physics, mathematics and humanities. This multidisciplinarity determines the specifics of the management model of the organization of scientific activity.

To control a real object, you need to develop a model that describes the behavior of the object. In our case, as a model it is advisable to use a formalized description of the set of business processes that underlie the organization of scientific activities of the university. The application of the process approach in management is now a promising area [27]. Using this approach, each business process can be considered as an information flow that receives information at the input and generates new information at the output. In the course of the business process, specific information describing the behavior of the process must be accumulated.

Different business processes are in constant interaction, exchange information (information flows circulate between them). To accurately describe the interaction in such a system, there must be an information model that would allow the accumulation of relevant information about business processes. Such a model and a model of processes that describe the organization of scientific activity form a management model. Thus, the information-analytical system developed on the basis of a set of these models can be considered as a management system for the organization of scientific activities of the university.

The creation of the model should begin with a study of the functional units of the university, which participate in the conduct and organization of scientific activities. Establish a common map of business processes, the place and role of each unit in the overall system of processes. Such a model will allow a global assessment of the research subject area and present a general system of interaction of objects of the subject area, in our case - the university departments and individual officials responsible for the organization of scientific activities. It is recommended to characterize each process according to such plan [28]:

1. The name of the business process.

2. Conditions for starting a business process.

3. Documents and information that arise during the business process.

4. Persons involved in the business process.

5. The purpose and results of the business process.

6. Other characteristics of the business process.

After completing the initial stage of modeling, we must obtain a detailed description of the subject area in the form of a business process model with a full definition of each process, identify the main functions to be provided by IAS, and, consequently, the main system modules to perform these functions. According to the received information we will develop functional requirements to IAS and to formulate strategy of its development for performance of the main task - management of the organization of scientific activity. The effectiveness of the proposed method of building a model of the processes of the studied subject area in the creation of IAS is due to the following factors:

- the model summarizes and systematizes information about the studied subject area;

- the received description of the system of business processes is a model of interaction of objects of the subject branch;

- the business process model visualizes information about the subject area, business process diagrams are clear and understandable to a wide range of people;

- the complete model of business processes describes in detail the functions performed by the participants of the activity, therefore, on the basis of the process model it is possible to identify the functions of the IAS.

To create a full-fledged model of management of scientific activity of the university within the IAS, only the functional requirements and the business process

model of the subject area are not enough, because there is a lack of "foundation" of the IAS - the data model. The next important step in the creation of IAS is the design of an information system data model. The data model is the structure of the relationships between the entities of the subject area, as well as a description of these entities. Entities are structures for storing the elementary components of information (a set of facts that describe a particular business process).

To build a data model, it is convenient to use entity-relationship model (ERM) and entity-relationship charts to represent the data model. The entity-relationship model (ER-model) is a data model that allows describing conceptual diagrams of the subject area. This approach is formalized, it is a set of rules that describe the method of modeling. In the course of ER-modeling we obtain a detailed data model of the studied subject area. The success and further development of IAS, and hence the reliability of the management model of the organization of scientific activity, depends on the quality of the constructed ER-model.

ER-model is used for high-level (conceptual) design of information systems and databases. You can use it to highlight key entities and identify the connections that can be made between those entities. When designing databases, the ER model is transformed into a specific database schema based on the selected data model (relational, object, network, etc.). The ER-model is a formal construction that itself does not determine the graphic means of its visualization. An entity-relationship diagram (ER diagram) is usually used as a standard graphical notation to visualize an ER model.

At this design stage, we focus on the data model architecture for IAS. As a result of ER-modeling, ER-diagrams of the studied subject area were obtained.

The complete ER-model for the studied subject area allows to get a global idea of the logical levels of IAS. With the help of diagrams at the final stage of ER-modeling, a clear idea is formed as to whether the IAS can meet the requirements set for it or whether it is necessary to make additional refinements and refinements of the data model. Thus, the ER-model allows without writing prototypes of IAS and implementation of program code to get an initial idea of the future of IAS. This technique is effective because it reduces labor costs in the creation of IAS. Thus, the data model obtained by the above method is an important element of the management model of the organization of scientific activity. At the end of the data model creation stage, the "foundation" of the IAS is laid and it is possible to create a database for the IAS (tables, keys, indexes, constraints and other objects) on the basis of the ER model. After completing the main stages of modeling, when there is a model of the studied processes of the subject area and a data model, the functions of the system are defined, you can start designing and creating IAS applications. After completion of all stages of development we receive integral system.

As the experience of creating and operating IAS support of various activities (educational, scientific, etc.) in educational institutions, for a successful implementation requires a high degree of readiness of universities to use automated information and analytical management systems.

The essence of monitoring the effectiveness of the information support system of research management in a higher educational institution.

The introduction of information support system for research management requires the use of monitoring, because the current activities of the educational process, identification of major trends in their development and objective assessment of actual results require long-term monitoring of scientific, educational and management activities.

Information about the main aspects of the educational institution allows to make effective management decisions in a timely manner, based on the reality of the state of the higher educational institution. After all, it is important to strengthen

management actions for quality indicators in education [29]. The initial data of monitoring include information on the current state of the higher education system, the main problems that inevitably arise in the process of implementing innovative approaches. The obtained data are analyzed in order to determine the main directions of development of the educational system and further forecasting.

Sources define the concept of "monitoring" as "control with periodic monitoring of the object of monitoring and mandatory feedback" [30]. Monitoring, are used to comprehensively study certain aspects of the functioning of the education system and its components. It can be performed to study various aspects of the educational process, such as monitoring the use of information and communication technologies during the educational process, monitoring the training of specialists in a particular educational profile, and so on. In fact, the process of obtaining and processing data on student achievement or research is also a form of monitoring.

Scientific sources use such concepts as "monitoring in education", "educational monitoring", "monitoring the quality of education", "psychological monitoring", "pedagogical monitoring". S. Silina interprets "monitoring in education" as a process of continuous, scientifically sound tracing of the pedagogical process of training in order to optimize educational tasks, as well as means and methods of solving them, in order to optimally manage the pedagogical process. Close to the above is the concept of "educational monitoring", which is defined as a system of organization of accumulation, storage and processing of information about the functioning of educational systems in their various manifestations, used to track the current state and predict major trends.

Using the term "tracking", which actually relates to the concept of control, however, we consider it necessary to emphasize that there is a difference between the concepts of monitoring and control.

Another basic concept related to the concept of monitoring is diagnosis. Diagnosis is made to obtain information about the status of the monitored object at a certain point in time or under certain circumstances. In this case, the current state of the object is determined relative to some normal (corresponding to the plan) state of the object. The evolution of the system over time, changes in operating circumstances lead to changes in the conditions of diagnosis. As stated in [31], in management diagnostics involves the study of the state of educational work on the subject.

According to researchers monitoring can be considered as a system of measures aimed at the accumulation and analysis of information used to study and assess the quality of training and management decisions, identifying characteristics and trends. Thus, in the field of educational activities, the purpose of monitoring is to build new and improve existing management systems for research activities of higher education in general and its structural units in particular. The object of monitoring is the system of management of research activities in the structural units of higher education institutions. The subject of monitoring the effectiveness of management of research activities at the departments of university institutes is the quality of training of future professionals. In accordance with the above purpose of monitoring, we will define its main tasks. These include the development of a clear system of criteria for evaluating the research activities of faculty and students and methods of applying such criteria in practice; development of methods of analysis of the received data on various parameters (quantitative and qualitative), for establishment of the positive and negative factors influencing functioning of system of research activity; creation of reporting documentation indicating possible ways to overcome negative trends.

The monitoring tasks formulated above make it possible to assume the plurality of monitoring objects, which is consistent with [14]. In general, structures,

roles, scenarios, situations, or functional aspects may be monitored in the research system. These include some components of the research system, the process of research, the process of training future scientists, methods and technologies used, the individual components of this process, its results, various activities of the subjects of the scientific sphere (units, managers at different levels, leaders of research projects, individual researchers).

To clearly define the subject of monitoring, we will explore the interaction of such concepts as efficiency, effectiveness and quality. According to Fazivtsi, the quality of education is a complex concept, which includes the quality of educational services provided and the quality of training results for future specialists. In this case, the quality of services provided in the field of education is considered as a set of characteristics of the educational process. The evaluated criterion is the results demonstrated by graduates (for example, evaluations of the final state certification or the number and rating of published scientific papers).

Let us establish a connection between the concepts of educational monitoring and the quality of educational services. To ensure quality training, it is necessary to comply with the requirements of the vocational education program, educational standards; availability of qualified complexes of educational and methodical materials, which received positive approvals of experts from among the teaching staff. In modern conditions, quality training is impossible without the use of modern information and communication technologies; taking into account the changes that have taken place in recent years in the field of mechanisms for dissemination and exchange of information. It should be noted that such changes affect the student community the most. An important factor is the use of practice-oriented teaching methods for maximum adaptation of graduates to practical activities, which, in our opinion, is fundamental for the formation of positive motivation. Quality training is impossible without a well-developed system of monitoring learning outcomes and providing feedback mechanisms for teachers to adequately assess their own activities. The direct indicators of the quality of the teacher's activity include the programs of educational disciplines and educational-methodical complexes of disciplines developed by him.

Effectiveness is an indicator of how well organized the management of research activities in the university and the extent to which the activities of the teaching staff affect the functioning of the management system and the training of future researchers.

The effectiveness of training allows you to assess the results of the functioning of the research system according to pre-established criteria.

The subjects of monitoring are the heads of higher educational institutions and their structural subdivisions, teachers and students. An important feature of monitoring the effectiveness of research management was its multilevel nature, which took into account the complex inter-entity relationships. Monitoring involved the use of control by heads of universities, research departments, research groups, heads of departments, student assets, as well as mutual control and self-control. The latter factors were clearly preferred during the monitoring.

An important feature of monitoring was its focus on the actual results of research activities. For this purpose, their expert analytical assessment was carried out, based on the results of which recommendations were formulated in the field of management of research activities of the university. This approach contributed to the development of all subjects of education and ensured the implementation of their subjective functions.

In practice, researchers usually focus on the functions of managing the process of obtaining information about the characteristics of the object under study, the next stage is forecasting and determining further response measures.

The main functions of monitoring include diagnostic, informative, evaluative, predictive, stimulating, anticipatory and feedback function. The diagnostic function is to identify the level of readiness for professional self-realization in the research field of the future specialist. The informative function is responsible for obtaining information by the researcher about the specifics of the professional evolution of the future specialist. The evaluation function works with real and expected parameters by comparing them. The predictive function provides prediction of ways of realization of own possibilities by the future researcher. The stimulating function is responsible for increasing the motivation to develop their own professional qualities. The preventive function is aimed at identifying and neutralizing those factors and conditions that have a negative impact on the development of professional qualities. The feedback function ensures that the future researcher receives adequate information about the level of their own professional development through self-diagnosis.

The information obtained during monitoring includes the following requirements - adequacy, accessibility, objectivity, completeness, relevance, timeliness, structure, accuracy.

The main requirements of monitoring researchers include: validity, objectivity, reliability, systematics and systematicity, humanistic orientation, taking into account the characteristics of monitoring participants.

Let us define these concepts in more detail. The concept of validity is associated with a complete and comprehensive correspondence between control measures and the studied characteristics, the presence of pre-established criteria for measurement and evaluation and methods of confirming positive and negative results. Objectivity is aimed at creating a unified environment for all participants in the monitoring, the use of generally accepted research methods and taking into account both positive and negative results. Reliability reflects the degree of similarity of research results performed in different places. Systematic and systematic is the conduct of stages and types of monitoring according to a predetermined scheme, taking into account all significant aspects of the object under study. The humanistic orientation is associated with the formation of a genuine interest in the results of those involved in monitoring, by creating a psychologically comfortable psychological atmosphere and helps participants to reveal themselves as much as possible. Taking into account the psychological and pedagogical characteristics of participants is associated with determining the educational level, qualifications, general development, individual orientation of the object to certain types of scientific activities, as well as the conditions of research that differentiates diagnostic and control tasks.

Let us define the most widespread types of monitoring. Basic monitoring is to control quantitative performance indicators by periodically measuring the basic characteristics of the functioning of research activities. Dynamic monitoring allows you to track changes in performance over time. Comprehensive monitoring can combine the above types and is aimed at obtaining the most complete array of information. Universal monitoring combines different types of techniques and can be applied to a wide range of research objects (scientific, educational, organizational, etc.). Competitive monitoring also works with different systems, but focuses on a comparative analysis of their structure and functioning.

The purpose of monitoring management systems is to create algorithms of actions of management structures to perform new tasks and improve existing algorithms according to native criteria. At the same time, the received information is collected and generalized to study the current state of affairs, problem situations, consider the prospects of certain innovations, etc. The result of monitoring is the formation of systems of recommendations for further activities of management

structures. The subject of management monitoring is the interaction of different management levels: rector - vice-rector for research - research department; supervisor - student.

In the literature, pedagogical monitoring is considered as a pedagogical technology of educational activities aimed at obtaining information about the educational process, its results in the educational institution [32].

Monitoring methods are aimed at:

- accumulation of factual information (verbal: conversation, survey, practical: qualimetry, questionnaires, practice, term papers and dissertations);
- information processing and recording: qualimetry, mathematical and static;
- systematization of the received information about the researched object (formation of conclusions);
- forecasting, forming recommendations for further activities.

The information obtained can be presented in various forms. For example, dynamic indicators on a certain time interval (academic year, semester), presentation of information by comparison with similar researches, complex representation (a number of parameters are considered at once) are displayed.

Successful monitoring requires compliance with a number of requirements described in detail in previous studies.

Thus, monitoring the effectiveness of research management in higher education - is to identify trends to improve/reduce the quality of training of future researchers by collecting, processing, storing and using information, assessing the effectiveness of the management of research and forecasting prospects for university development in general.

Monitoring the effectiveness of research management in higher education is a complex system, the elements of which are the purpose and objectives, object and subject, requirements, forms, functions, methods, conditions, types, evaluation base and levels of monitoring. In our opinion, one of the important elements of a holistic monitoring system is the control and evaluation of scientific achievements of future specialists.

Criteria and performance indicators of the information support system of research management. Evaluation of the effectiveness of management of research activities in higher education is carried out using appropriate indicators - indicators.

The indicator in education is interpreted as a significant statistical array that provides information about the parameters, operation in static and dynamic modes and the results of the management system of research activities and its individual components.

Monitoring the effectiveness of management of research activities in higher education depends on a correctly defined assessment base, ie a set of criteria and indicators by which the level of quality training and activities of teachers and students. Evaluation of the results of management of research activities in a higher educational institution was carried out according to such criteria as the quality of research work of the teaching staff in the higher educational institution; scientific achievements of students of higher educational institution; the quality of the research component of the organization of the educational process in a higher educational institution. Consider them in more detail.

1. *The quality of research activities of teaching staff in higher education.*

The growth of the effectiveness of management of research activities in higher education is achieved through quality training of faculty, in particular the state of scientific potential of teachers. The higher the percentage of teaching staff has academic degrees and academic titles, the higher the indicators in the educational process and scientific work are recorded.

The effectiveness of research activities of the teacher was determined by the preparation of a PhD or doctoral dissertation, the availability of scientific publications (monographs, articles in peer-reviewed publications, abstracts, other publications), scientific guidance of graduate students, applicants, graduate students, students.

2. *Scientific achievements of students of higher educational institution.*

Monitoring of the quality of students was carried out for a different number of students, starting with individual academic groups, streams or courses and ending with the higher education institution as a whole. The qualitative composition of students was assessed by the following parameters: the average score of the certificate, the results of external independent assessment; average score of input control scores; participation in various types of university activities (research, education, public); attitude to scientific and industrial practices; current and semester success.

Participation in these activities (except for the actual educational and research) testified to the active life position of students. If a student did not participate in the mentioned types of extracurricular activities of the university, it was evaluated at 0 points, if he performed one-time assignments - 1 point, showed leadership and organizational qualities in extracurricular activities of the university (in self-government, conferences, competitions, etc.) - 2 points.

To study the effectiveness of the system of information management of research activities, the following system of criteria was formed:

- formation of graduates' professional knowledge and skills that meet the educational and qualification characteristics and the list of competencies of the specialist);
- assessment of graduates' readiness for independent scientific activity (high, medium, low levels);
- self-assessment of graduates' readiness for independent professional activity (high, medium, low levels);
- assessment of graduates' ability to innovate;
- rating of graduates;
- personal achievements of graduates (scientific works, victories in competitions, Olympiads, awards, inventions, patents);
- shortcomings in the work of graduates;
- management's attitude towards graduates.

3. The quality of the research component of the organization of the educational process in higher education.

We take into account the fact that the quality of the content of training of future researchers is due to the availability and proper implementation of regulations by the university management, faculty and students.

It is recommended to check the availability and quality of the long-term university development program approved by the rector's order for 5–7 years at the level of the Academic Council and the Scientific Council.

We have identified the following indicators that determine the level of development of the subjectivity of the participants of joint interconnected activities: tolerance, initiative, activity, organization, responsibility, focus on colleagues, understanding and acceptance of others, desire for cooperation, etc. The main indicator of the development of subjectivity is the guideline for cooperation and mutual understanding (multi-subject orientation).

Analysis of the organization and monitoring by the subjects management in higher education. In the process of implementing a system of information support for the management of research activities by the university administration, heads of structural units (identified as the object of monitoring) together with the research department of the university, the following actions can be implemented (as an example):

- organization of monitoring the implementation of development programs of educational and scientific institutes (faculties), departments, research groups, laboratories, their target programs, current projects, as well as analysis of monitoring results;

- organization of a comprehensive analysis of the implementation of university projects, measures aimed at ensuring the implementation of the concept of university development, as well as programs for the development of research activities; integration of self-assessment and self-analysis with mutual analysis and mutual assessment;

- formation of annual reports of structural units on the implementation of research development programs;

- conducting weekly operational meetings (directorates of educational and research institutes/deans of faculties) in order to analyze the activities of structural units of the institute/faculty;

- identification of problematic moments in the implementation of projects, implementation of individual tasks, formation of special conditions for those participants who have difficulties in performing common tasks, providing operational assistance, adaptation of activities to objective external conditions, ensuring positive dynamics of results;

- assistance to individual subjects of research activities in adjusting their own activities in accordance with the decisions obtained in the course of multi-subject interaction;

- discussion and coordination of positions on the adjustment of the research development program and its management system, joint refusal to implement ideas that are ineffective under the given conditions, as well as on new ideas that appear during the work;

- support of individual and group subjects on the way to rethinking their own experience, finding the implementation of new forms of activity by developing and testing innovative ways of working.

During the monitoring, the heads of institutes (deans), departments, temporary creative teams use the following forms of work:

- group analysis and evaluation of the process of preparation and implementation of all activities, projects related to the implementation of promising and targeted programs of educational and scientific institute (faculty), department, research group with simultaneous self-analysis and self-assessment of individual plans;
- annual progress reports on the implementation of research development programs and targeted programs;
- monitoring of subjective development of participants of research activity and efficiency of organization of scientific, educational, methodical, and other projects within the institute/faculty;
- trainings and seminars for teachers and students aimed at forming reflection;
- modification of target programs of the institute/faculty, scientific groups, departments on the basis of group reflection of innovative and experimental activity;
- modification of the content and methods of the institute/faculty, departments, research groups by taking into account modern requirements for training, processing the results of the experiment and producing new ideas;
- adjustment of the activities of entities through a comparative analysis of the basic plans and the actual results of activities;
- active acquaintance of subjects with innovative approaches to the organization of scientific activity and management;
- support of individual subjects on the way to comprehension of own experience on the basis of exchange of experience between institutes/faculties, departments, separate researchers, acquaintance with modern technologies;
- organization of mutual correction of actions on the basis of joint activities to involve the most competent specialists.

Monitoring of the effectiveness of the information support system for the management of research activities in institutes (faculties) is organized and controlled by directors (deans) and their deputies for scientific work. The organization of monitoring the effectiveness of the implementation of the system of information support for the management of research activities in higher education consists of the following stages: preparation of monitoring; data collection and analysis; generalization and publication of results; formation of a report and recommendations on the prospects of development of the studied object.

At the initial stage, the initiator of the monitoring and its direct executors agreed on the main goal. In the future, the main goal defined was specified and separate goals were outlined for it. After such clarification, the information needs of monitoring, criteria and indicators by which the observed objects or phenomena were to be assessed were determined. To successfully pass this stage, the customer had to clearly define a number of tasks, namely, what necessitated the need for

monitoring, what characteristics need to be assessed during monitoring, what is the purpose of the information, as the customer sees his own actions based on monitoring results.

At the next stage, a monitoring plan and methodological principles for its implementation were developed. To do this, the objects of research and evaluation criteria were determined, indicators for evaluation were established, and adequate methods of data collection and processing were selected. Also at this stage it is important to determine the research methodology and the main issues of the actual organization of monitoring, which will allow it to be conducted successfully. Particular attention should be paid to supporting the motivation of all participants to participate in the study.

Completion of the preparatory stage is the compilation and testing of all diagnostic diagnostic materials, development of its program and coordination with the customer. Diagnostic materials include questionnaires, tests, documentation processing algorithms, etc.

Data collection and analysis. Sociological methods and tools were used to study the activities of experimental groups. The most common of them are: examination of curricula and programs, sociometric surveys and pedagogical measurements, study of the opinion of recipients, analysis of available documentation. The main criterion in choosing methods and tools was their ability to best meet the information needs of the study, namely, to form the most complete array of data reflecting the real state of affairs of the object under study, the peculiarities of its operation under current conditions. The principle of reasonable sufficiency was applied to the amount of data obtained - they should not be too much, which would complicate the process of processing and detection of significant factors, as well as not too little, which, of course, would not give a complete picture of the object.

The processes of collecting and analyzing information took place simultaneously. The parallel performance of these tasks made it possible to adjust the process of searching for additional data, use other sources of information and promptly process the data that were needed during the monitoring process. The obtained results were checked for reliability and validity. For quantitative processing of the obtained materials, statistical methods were used, calculating the basic statistical characteristics (arithmetic mean, variance, correlation coefficients).

The results of the monitoring revealed a list of promising areas of work of the administration, directorates, departments, research groups, teachers aimed at improving the quality of scientific work of future professionals, in particular:

- focus on high-quality mastering of basic professional knowledge and skills: development of special courses and special seminars dedicated to current scientific issues of today and aimed at forming in future professionals a sense of belonging to promising areas of work, relevance of knowledge not only now but also in the future; increase in the number of hours allocated for seminars and practical classes; involvement of leading specialists from specialized and related fields of science, industry for thematic lectures, seminars, focus groups, in order to form in students an objective picture of future professional activity;

- organization of students' scientific work: involvement of students in international, national, regional scientific-practical conferences and seminars and Internet conferences; involvement of students in scientific competitions, Olympiads, exhibitions; creation of a university journal for the publication of student research; increase in the number of hours of study load for the management of scientific works of students, taking into account the results of scientific work of students in the rating assessment of the faculty;

- taking into account the requirements of the credit-module system to improve the content, methods and forms of the educational process: bringing indicators of study time and characteristics of training programs in line with the standards of European universities; reduction of teaching load of teachers and optimization of document flow; introduction of information and communication technologies in higher education, in particular, development of an Internet portal dedicated to topical issues of science and professional activity for teachers and students, use of modern interactive technologies for research, interaction of teachers and students (groups, forums, etc.); use by teachers of various forms of individual work with future researchers; assistance to students in organizing independent work;

- logistical and informational support: equipping educational and scientific laboratories with modern devices and installations; increasing the number of audiences equipped with multimedia; increase funding aimed at providing scientific literature and modern periodicals, in particular, connection to existing electronic libraries, funding subscriptions to the most current publications; financial support for the participation of teachers and students in international and national scientific conferences, competitions;

- advanced training of teaching staff: organization and financial support of internships for teachers in leading universities; organization of lectures and seminars of specialists from other higher educational institutions of Ukraine and abroad; organizational and financial support for teachers who use modern methods of organizing educational and research activities; assistance to teachers in mastering foreign languages and in introducing bilingual courses into curricula.

The above promising areas of work reflect the expectations of the subjects of monitoring, aimed at improving the conditions of research activities of the university as a whole. The nature of multi-subject interaction of recipients, their involvement in joint activities at different levels and the ability to perform different roles in the mode of collective work, to find mutual understanding with partners, the desire to cooperate were assessed by the nature of individual actors. Yes, there was a fixation of the frequency of business contacts initiated by the subject; accounting for conflicts to which the entity has been involved; study of the degree of coordination of actions and the degree of satisfaction of subjects with joint activities.

The results of monitoring showed that in order to form a stable motivation for scientific activity in the system of higher education, initiative, tolerance, activity, responsibility, democratic principles of organization of relations of subjects of educational and scientific activity should be actively implemented, their functions should be expanded.

Generalization and publication of monitoring results. At the initial stage, the conditions of use of the information obtained as a result of monitoring, its dissemination and ownership were determined. The importance of this issue is due to the fact that the subjects of monitoring are university staff and, in fact, monitoring is a certain interference in their professional activities and teamwork.

To address the issue of information circulation, the organizers acquainted teachers and students with the preliminary observation data, adjusted the diagnostic monitoring materials, its methods and plan to avoid inaccuracies and misunderstandings, and ensured the confidentiality of information. Summarizing the results helped to obtain truly objective information, and its disclosure did not violate ethical standards. Each participant received information about his participation in

the study. The initiator received the most complete information on the results of monitoring, the actual content of which was determined by a previously concluded agreement. One of the conditions of the agreement was that the initiator has no right to data that subordinates, for personal reasons, do not want to disseminate.

The purpose of publishing the results of the monitoring was to provide feedback to obtain information on its effectiveness. Based on this information, the evaluators made adjustments to the strategy, methods and tools. This type of activity is extremely important.

As a result, the customer received sufficient information to form and make a certain set of decisions, adjust their own activities. On the other hand, during the discussion of intermediate and final results, the monitoring performers were able to include in the report only verified information and make an objective assessment of the state and possibilities of the research object and take into account inaccuracies and errors in organizing and conducting monitoring. .

Reporting and making recommendations. The report is the final document that was executed after the end of the monitoring. It is based on data and generalizations obtained in the process of monitoring research. The prepared report had the optimal volume and measures of detail, contained differentiated information on all aspects of the study, took into account the requests of the initiator. To do this, the degree of detail of the report was previously stipulated in the part concerning the intermediate results and methods. The main part of the report was devoted to the final results, general conclusions and recommendations.

Based on the results of the monitoring study, the following recommendations were formulated:

1. For long-term and multi-parameter monitoring research it is expedient to prepare the most complete report containing the description of conceptual bases, the received results in the textual, graphic or tabular forms, examples of the used methods and means, analytical comparisons and generalizations. A short summary is formed separately, containing generalized results and conclusions with reference to the materials of the full report.

2. The report should reflect not only the current state of the object of monitoring research. It should contain analytical generalizations, a description of trends and patterns that form the basis of conclusions and recommendations on possible ways of development of the subject, proposals for changes that should be implemented, strategies for future development of the object. Such data are of a recommendatory nature and should help the initiator of the monitoring study to develop its own program of changes in the system of organization of work in certain areas.

Monitoring the effectiveness of the information support system of management of research activities in the structural units of the university allowed to provide feedback between the process of achieving goals and the goals themselves, defined by educational and scientific institutes, departments, research groups, educational institution; to evaluate the effectiveness of innovations, the productivity of management activities of heads of institutes, departments; identify typical problems characteristic of the activities of institutes, departments, research and teaching staff; control over the implementation of promising and targeted development programs of educational and scientific institutes, departments, research groups, self-development plans of participants in the educational process; develop action programs to adjust the management system of research and educational activities, identify areas for addressing existing problems. The analysis of the results of the

monitoring study made it possible to determine the generalized indicators of the effectiveness of the research management system of the university according to the following criteria: the quality of the educational process in the part responsible for research activities in the university; the quality of research activities of the teaching staff; the level of scientific achievements of university students. It was important in determining the effectiveness of the information system of management of research activities of the university was compliance with certain requirements:

1. the relationship between performance indicators of research management and its objectives;

2. reflection of both procedural and effective aspects of management activities with the help of a certain set of indicators;

3. full reflection of the main connections, relationships characteristic of the studied system.

The identified generalized indicators of the effectiveness of the information management system of research activities reflect such a feature as the focus of activity of individual and group subjects of the educational process on the development, implementation and implementation of long-term plans and programs for the pedagogical system of universities and its subjects.

To identify the effectiveness of the information management system of research activities in the university, a comparative analysis of statistical data of the research department, reports of heads of departments of the university, documentation of departments, divisions, research groups, observation results, questionnaires in 2007 and 2012.

It is established that the most significant increase in the effectiveness of research management occurred in terms of indicators that characterize the system of planning and information support. This is explained by the fact that the introduction of a system of information support for the management of research activities primarily involved the provision of forecasting, identification of development prospects, long-term goals and ways to implement them.

Significant improvement in the effectiveness of research work has also occurred in those indicators that characterize the formation and development of international research activities of participants in the educational process. These results are explained by the focus of management activities to intensify research activities to ensure multi-subject interaction of participants in the educational process, joint regulation of activities, constant business communication, communication between entities, the dominance of cooperation; to mobilize the team to implement the development strategy, the maximum possible realization of the potential abilities of teachers and students.

2. Conclusions

It is established that the introduction of a system of information support for the management of research activities contributed to improving the quality of teaching staff, the growth of student achievement.

Thus, it is established that the introduction of a system of information management of research activities in higher education in general contributed to the growth of performance management of research activities and improve the level of training of future professionals.

DOI: http://dx.doi.org/10.5772/intechopen.100512

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Chapter 2

Active Learning: The Panacea to Miseducative Practices in Teacher Education

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Abstract

Traditional education has ripple effects in education. The way the educator was taught is almost always the way the educator teaches the learners. Traditional education has a narration sickness (Freire, 2000) and the so-called educators are proselytising ideologues who are after the production of copy cats. Active learning in teacher education is anchored in reflective thinking on all practices. The teacher education student should be encouraged to embark on action research which makes one to be introspective. Thus action research makes the teacher involved in active life-long learning. The teacher who has been groomed in action research abhors routine and ritualistic methods of teaching. The action research oriented teacher makes learners active in learning episodes.

Keywords: active learning, mis-educative practices, teacher education

1. Introduction

The educator has an unequivocal role in the education situation, that of facilitating learning. By and large, the extent of learning is influenced by the learning approach that is employed by the educator. Some educators are obsessed by the monological approach which has emphasis on the teacher-centred approach. The educator becomes more active than the learner. The monological approach is condemnable [1]. The approach is deemed vicious in terms of development of the disposition for life-long learning. The more virtuous approach to effective learning is active learning which shares a lot of virtues with the dialogical approach.

Active learning has been considered virtuous by academics in many nation states. There is the Chinese adage that emphasizes on active learning which reads, 'I hear and I forget, I see and I remember, I do and I understand'. Active learning is critical in teacher education since without it there could be stagnation in the construction of knowledge. Some educators have a tendency of transmitting almost the same knowledge using the same mode that their educators transmitted to them. In such a situation, education becomes a means for the perpetuation of the status quo. The teacher education learners who are exposed to the active learning approach are likely to engage the learners they would have before them in active learning episodes.

The purpose of this chapter is an exposition of discourses on the essence of active learning in teacher education. There are explications of the concepts and practices that are indispensable to active learning. The intended beneficiaries of active learning, the teacher education learners are always experiencing situations which are vicious and/or virtuous to active learning. In order to minimise speculations about the practices that promote or stifle development active learning, an empirical investigation was done with learners exposed to action research and traditional research. The interpretations of experiences of the learners are used as excerpts in corroboration of some standpoints in the discourses.

2. Active learning

Active learning is an approach employed by the educator which actively engages the learners as participants in their learning. The learners who are active find learning more interesting and meaningful when new knowledge, skills and attitudes are contextualized to their previous experiences and what they are to experience in the immediate future. In active learning, experience is not about what happens to the learner but is concerned with what the learner does with what happens to him or her. The experience of the learner should always be given meaning by him or her through reflective thinking.

The term 'active learning was coined' by Charles Bonwell and James Eison in 1991 in their seminal book entitled *Active learning: Creating excitement in the classroom*. In this book, active learning is considered to be the panacea to pedagogic and andragogic ills that emanate from monological, mis-educative techniques of traditional education. The traditional education techniques can be traced back to the 14th century. The then educators of the Medieval times were oratory and narrative of knowledge that were got from scarce resources. The modus operandi of learning of the then times was the taking of copious notes and memorizing information.

Active learning is informed by the constructivist philosophy which was advocated for by theorists like; Dewey, Vigotsky and Piaget. Constructivism focuses on constructing meaning from experiences when one reflects on the experiences. Thus in this context, active learning is a reflective activity which implores learners to learn how to learn to construct meaning and subsequently knowledge.

Without guidance from constructivism, there could be rote learning as an approach that is employed by some teacher educators. The teacher educators are referred to as lecturers and they live to the label when they succumb to the narration sickness [1]. In the wake of constructivism that emphasizes on creation of knowledge, the educators should involve learners in active learning. The learners especially those at tertiary level should be considered to be responsible learners who can learn more meaningfully when they are actively involved rather than being exposed to passive listening and note taking. The learners should be engaged in higher-order thinking which entails reflective thinking.

3. Essence of active learning

The education system of any nation state strives for the provision of authentic education which is concerned with human development in all the spheres of life. In many education systems, authentic education is obscured and thwarted by the craving for high paper education credentials which are acquired by memorization of stale knowledge. If this was the authentic yardstick for quality education, then

the panacea to socio-economic and political problems could have been considered got. The criteria for high level of education should be concerned with wisdom to interact with one's environment for the enhancement of societal development. The active interaction with the environment to give it meaning is critical for realisation of authentic education which involves the interpretation of experiences in order to acquire requisite knowledge, skills and attitudes for both personal and societal survival. One could have attained a high level of paper qualification but without a disposition and knowledge of learning how to learn to attain authentic education. The contradistinction of authentic education is illusory education which is characterised by the regurgitation of notes given by the 'educator' [2]. Such 'education' comes about through non-educative experiences and mis-educative experiences which are mal-educative experiences and are the antithesis of active learning [3].

The involvement of the learners in the mal-educative experiences is reinforced by a defective education system. Some 'educators' perpetuate the mal-educative experiences by employing rote and ritualistic approaches to learning. In other words there is status quo in education whereby some 'educators' with 'experience' have developed some habits that define their interactions with the learners. They become resistant to change since anything that is new has the potential of throwing them in the zone of incompetence. For the newly 'qualified' teachers, there is a tendency that they interact with the learners in the same manner in which their 'educators' interacted with them. More so, the parents of the learners are sceptical about any education interactions that are radically different from what they experienced [4].

Education that is hinged on the maintenance of the status quo alienates the learners from the realities of life and is not meaningful. Thus educators should be aware of that education which is meaningful accords the learner the freedom to intellectually and actively interact with the environment in order to interpret it. Such a model of education is democratic since it values the learners' experiences in the creation of a collective body of knowledge about the environment [3]. When the learners are actively involved in the interpretation of the reality around them, there is authentic education [2]. In defining education, it is imperative to include the learners' experiences. Thus education is the reconstruction or reorganization of experience which adds to the meaning of experience, and which increases one's ability to direct the course of subsequent experience [5]. The reconstruction and reorganization of experiences are hinged on reflection which is about the processing of the meaning of experiences. Reflection is indispensable to interpretation of experiences. Thus Aldous Huxley postulate that experience is not what happens to an individual, it's what the individual does with what happens to him or her [6]. The emphasis is on reflections on the experiences.

Education that is meaningful is focused on the quality of experience and the reflections thereof. There are two closely intertwined principles which are interaction and continuity [5]. The principle of interaction is about the learner's active involvement in learning when the learner gets inputs from the active interaction with the environment for the creation of knowledge. Interaction which is reflective is a critical hallmark of active learning.

The continuity principle is about how the active learning experience influences future learning experiences [3]. Thus the continuity principle calls for linkages of present experiences with past to illuminate the future and subsequently evoke the motivation of continued learning. Spontaneously the principle of continuity is when the subject-content that the learner is supposed to learn about has been psychologised. The psychologising of subject-content is about relating it to the learners' prevailing experiences which are the real life-experiences [5].

4. Educator responsibility

The responsibility of the educator is to create educative experiences that would result in the development of the learner through active learning [5]. The educator should take into consideration the requisite educative experience principles which are continuity and interaction. Thus the educator should design education experiences for the learners that are hinged on the learners' past experiences. In other words, the educator needs to be able to design for the learners, meaningful and interactive experiences that are connected to the learners' environment and experiences for them to be actively involved in learning.

The learners should be made to think reflectively about their experiences in order to learn from these experiences. It is the responsibility of the educator to critically interrogate his or her teaching practices in order to accommodate learners' experiences that would make their learning more meaningful. The educator should be able to realise his or her procedural epistemic gaps that stifle reference to learners' experiences [7]. Thus the educator should employ the dialogical techniques that call for reflection on the experiences of both the educator and the learners.

5. Reflection and reflective practice

Reflection is the requisite for experiential, active learning [5]. Dewey considers reflection as a systematic, complex, rigorous, intellectual, and emotional process that gets improved through continuous processing of experiences. In other words, reflection is a meaning-making process that deepens the understanding of one's experience for the illumination of interpretations of the other experiences. Reflection is the nodal point between past and present experiences. Thus a realisation of the relationships and connections of experiences enhances continuity of education.

The motivator of reflective thinking is the doubt that one has about experiences [5]. The experience which is perplexing needs to be analysed and interpreted by reflecting on the outcomes of employing past experience and prior knowledge. When reflection is incorporated in practice, then there is reflective practice which has the potential to dissipate mis-educative and non-educative experiences which are associated with non-active learning.

Thus through reflective practice, educators get engaged in continuous professional learning and learners get engaged in active learning. Both the educator and learner are conscientized to look back on their practices and reflect on how best to achieve optimal learning outcomes.

6. Experience

Experience is the conscious involvement of a person in a situation or event which requires that one thinks, feels, does and concludes at the time or immediately thereafter [8]. Thus experience is given meaning and value when one does some reflections which involves recapturing experiences, thinking about them, mulling them over and evaluating them.

7. Experiential learning

Experiential learning is akin to active learning and is reactive to traditional learning which according to Dewey was anti-democratic in terms of selection of

content and learner participation in learning [9]. Traditional learning does not consider the learners' experiences as valuable thus the learners are found to be not actively involved in their learning. Non-active learning is a mal-educative practice which can be mitigated by experiential learning which stresses on that the goals of learning are best achieved through experiences that are directly related to the learner's life [3]. In experiential learning, learning happens through actually doing something and subsequently reflecting on the experiences. The educators are not supposed to employ the monological teaching techniques in which content is presented via lectures but through dialogical techniques which employ continuous conversations about how to meaningfully interpret the experiences in the learning situations [1]. The dialogue that occurs in the interpretation of experiences entails reflection and subsequent explanations of the relationship between experience and knowledge. Thus experiential, active learning is anchored on experience and reflection.

Reflective, active learning is aimed at learning how to transform experience into knowledge and how to employ the knowledge for individual and societal development [1, 3]. However, active learning from experiences is not the panacea to the vices of traditional education *per se*. It should be borne in mind that not all experiences are essentially virtuous for learning. The virtuousness of experiences should be judged focusing on whether the learner was developed; intellectually, emotionally and socially. The development is manifested in the insatiable desire to learn which culminates in lifelong learning.

8. Active learning in teacher education

8.1 Reflection-in-action

Active learning involves intellectual engagement in the form of reflections during the course of learning. The learner does reflection-in-action which entails active, persistent and careful interpretation of experiences for the construction of new knowledge [10]. Reflection-in-action is indispensable in action research where practice is critical. The employing of reflection-in-action in professional practice makes the practitioner realize his or her shortcomings and then think of mitigations thereof. Thus the practitioner reflects in action by evaluating the efficacy of the interactions during the teaching-learning situation [11].

Reflection-in-action incorporates a wide range of the practitioner meta-cognition of activities during the teaching-learning situations. The practitioner reflects on reflections in the creation of new knowledge about approaches he or she employs. The learner also reflects on reflections when refining the conceptualization of phenomena. Reflection-in-action of both the practitioner and learner ignites dialogue for the construction of knowledge.

8.2 Reflection-on-action

Reflective practice entails reflection-on-action which engages the learner in a process of continuous, active learning [12]. The reflection that the learner does on own actions is interrogative of experiences in order to interpret the experiences. Reflection-on-action involves paying critical attention to experiences which are the basis for giving meaning and practical value to learning [13]. Thus learning outcomes should be examined reflectively and reflexively to give them meaning.

Reflection-on-action is indispensable in practice-based learning that the teacher education learners are involved in especially when they are engaged in action research.

The learners get involved in learning from their actions rather than from the transfer of knowledge by the 'educator' [14]. The learner who is involved in action research develops the disposition of reflection on actions. There is conscious scrutiny of emotions, experiences, actions, and responses to situations in order to gain insights of interpretations of knowledge being gained. The learner does not merely review the past actions and events but processes them in order to construct new knowledge [15]. Thus the learner understands phenomena within his or her own context which provides a strong anchorage to understanding phenomena at global levels [16].

The practice of reflection-on-action is critical in the field of teacher education and teacher professional development since it is the basis for many programmes of initial teacher education [17]. The teacher education learner is expected to embrace the practice of reflection-on-action since it entails the process that the practitioner studies his or her own teaching methods to discover the best practice of learning facilitation [17, 18].

Reflection-on-action can be regarded as learning from experience and is critical to the learner taking responsibility in the learning situations. The learner gets engaged in meta-cognition [19]. Without reflection-on-action, learners are not intellectually active in their learning so as to come up with concrete knowledge about phenomena.

Reflective practice moves teachers from their knowledge base of distinct skills to a stage in their careers where they are able to modify their skills to suit specific contexts and situations, and eventually to invent new strategies [20]. Thus through reflective practice educators are able to develop themselves beyond existing theories in practice and become responsive to the dynamic environments of their day to day practices.

9. Action research in teacher education

Action research embarked on by teacher education learners is hinged on praxis. The learners are supposed to be actively involved in testing the feasibility of theories in the contexts that they will be practicing. In praxis, there is also a focus on practice for theory. The engagement of the teacher-education learners in action research enables them to generate theory when they are practicing in their contexts.

Action research is a mode of research in quest for the requisite knowledge, skills and attitudes about how to improve on one's practice. The educator-researcher embarks on research to improve on the self in terms of teaching skills, techniques and strategies. The value of action research is in the improvement that occurs in classroom interactions. Action research can be viewed as a tool for classroom practice reform [21].

Action research is defined as;

> *... a form of collective self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social and educational practices and the situations in which these practices are carried out [22].*

Thus action research is a form of applied research which is done by practitioners to try to solve immediate problems in their working environments [23]. The teacher-education learner is encouraged to become an educator-researcher bridging the gap between practice and research. Thus the special feature that distinguishes action research from other forms of research is that research is conducted at the

same time as action is being taken to improve on the practices [24]. The purpose of action research is for the practitioner to investigate and improve own practice and the process of action research is one of self-study [25].

10. Benefits of action research

The teacher-education learner who embarks on action research implicitly engages him/herself in active life-long-learning which ultimately develops one into an effective educator. Effective educators are themselves reflective-educator-students who research on ways to enhance their existing procedural knowledge. The educator who embarks on action research never boasts of experience of having so many years as a practitioner. He or she becomes aware of the truism that experience is not about the number of years spent doing routine things but how one has geared up his mental agility to find solutions to problems. The educator thus considers himself or herself as the educator-student-researcher and the learners are considered as the research informants. The educator is encouraged to be introspective whenever there is a problem. He or she is expected to blame the self before blaming anyone else for any educational problem experienced by the learner. Thus the educator is oriented to focus on the problem in relation to personal shortcomings.

Action research offers an alternative to educators who have been oriented to look to others rather than to themselves and their students to find ways for improving on learning [26]. Thus action research empowers the practitioners by promoting their involvement, engagement, participation and critical consciousness in exploring strategic and effective actions to improve professional competency and the quality of learning [25].

The educator who embarks on action research develops open-mindedness about the educational issues [27]. One who is open-minded is receptive to new knowledge and hence develops faster in the profession. The educator finds to it that the sources of knowledge are not the published texts only but the colleagues he or she works with and the learners whom he or she teaches.

An educator who embarks on action research does not experience solitude in research. At some instances, action research requires some collaborative effort from colleagues [28]. The colleagues are there to reflect on the educator-researcher's performance and then they advise accordingly. Thus the educator-researcher has an opportunity for professional discourses with the colleagues. The partnership that is created is conducive to sound professional development since the educator-researcher gains some insights on issues to consider when reflecting on the self [16]. Thus action research encourages the sharing of reflections and makes the educator willing to learn from their mistakes and improve on their practice for the benefit of everyone affected by it.

The educator who is an action researcher has a proclivity towards initiating some changes in the ways of facilitating learning [29]. He or she is never contented with how he or she does his or her work. The educator always researches on the self in relation to educational issues so as to anchor his or her practices on functional, epistemic rationalities rather than on technical rationality.

Action research encourages the practitioner to get into partnerships with colleagues in studying the self in order to improve. Thus the practitioners individually and collectively try to understand how they are formed and reformed as individuals, when they work together to improve processes of teaching and learning in the classroom [30]. Action research is participatory in the sense that practitioners can only do action research "on" themselves, either individually or collectively. It is *not* research done on others.

Action research engages the practitioners in examining the social practices that link them with others in educational interaction. The practitioners explore their practices of communication and social organization and try to explore how to improve their interactions by changing the actions that they are comprised of.

Through action research, practitioners explore the ways in which their practices are shaped and constrained by wider technical rationalist ideas which are socio-cultural, academic, economic and political. The teacher-education learner does not become parochial in employing the age-old theories and personal hunches.

Action research aims to make the practitioner investigate reality about the self in order to change it [31]. In particular, it is a deliberate process through which practitioners aim to transform their practices through a spiral of cycles of critical and self-critical action and reflection.

11. Rationality for dearth of active learning in teacher education

Some teacher-education learners enter higher education without the motivation of being actively involved in their learning. They do not think reflectively about their experiences [32]. One of the reasons is that some college lecturers follow a curriculum design that focuses on subject-matter content when teaching rather than on the development of reflective thinking [33]. The lecturers who simply follow guidelines in curriculum documents do not teach the teacher-education learners to be intellectually involved [32]. Such lecturers have a lecturer-centred orientation that incorporates misconceptions that lecturing is about imparting information or transmitting structured knowledge [34]. They use retrieval or recall types of questions which inhibit reflective thinking [32].

The lecturer-centred teacher educator is obsessed by employing monologic techniques that are manifested among other ways in the use of the presentation and demonstration methods. The learners are supposed to absorb bodies of 'stable, eternal knowledge' that are transferred by the lecturer. The learners are immersed in a mass culture which is supposed to be contented with the status quo [35]. The aspects that imply active, intellectual involvement such as inquisitiveness, analyticity, reflectivity, reflexivity and truth-seeking are consciously thwarted. The learners are deprived of learning how to learn [36]. Thus the monological techniques obviate learner active involvement in their learning.

12. Learner reflections on their learning

Some teacher education learners were interviewed about their reflections on their learning experiences when they were carrying out research projects. The interviews were premised on the phenomenological hermeneutics paradigm [37]. The purpose of the phenomenological hermeneutics paradigm is to understand the lived experiences of the informants from their own perspectives [37–40]. These lived experiences were expressed in the informants' own words to authenticate the interpretations of the researcher.

The informants were selected purposively to have balances in the type of researches that they carried out and the sexes. They were considered to be information-rich on the basis that they had experiences in either traditional research or action research which they reflected upon with regards to learning efficacy. The table below shows the type of research and sex distributions of the informants.

Informant	Research type	Male	Female
Informant 1	Traditional		X
Informant 2	Traditional		X
Informant 3	Traditional	X	
Informant 4	Traditional	X	
Informant 5	Action		X
Informant 6	Action		X
Informant 7	Action	X	
Informant 8	Action	X	

The interviews were audio-taped in order to capture all the data that were being generated. The data were then transcribed. Analysis of the data was done by employing the thematic approach while focusing on the Johnson and Christensen method which generates themes from excerpts in the interviews transcripts [41–43]. The emic interpretations (informants' reflections on experiences in their own words) informed the *etic* interpretations (the researchers' reflections on informants' interpretations) [23].

The reflections of the teacher education learners on how they experienced learning when they carried out researches are classified according the value that they attached on their experiences during carrying out researches.

13. Non-educative experiences

There are instances in teacher education when learners are exposed to non-educative experiences which do not afford them any time for active learning when they reflect on the experiences [7]. In formant 1 postulated,

> *"I am not aware of what is going on in my research project. My supervisor tells me what to write. I am doing research just for the sake of it. I want a diploma and nothing more."*

The learner is not actively involved in learning and is not motivated to do further learning. The 'educators' who do not engage learners in active learning, perpetuate non-educative experiences and are bearers of incontrovertible knowledge since their experiences dominate the experiences of the learners [4, 44]. Confirmatory remarks were given by informant 2 who posited;

> *"My supervisor gave me the topic to research on. What disturbed me most was that the problem I was forced to research on was not realistic since I was not experiencing it. To me it was an imaginary problem."*

The situation in the non-educative experiences is that 'educators' do not engage learners in active participation in the teaching-learning situation and the learners are made to be aware of that their experiences are sanctioned by the 'educator' since all interactions are enforced by rules and regulations [41]. The 'educator' is the moderator of all experiences and reflections are determined by him or her. Thus the meaning of experiences is vicariously made by the 'educator'.

Furthermore, non-active learning is non-educative since the learner becomes docile, receptive, and less reflective on the experiences [3]. The learners' experiences are not considered since they have the potential to conflict with the status quo. Informant 3 made the remark;

> *"I went on teaching practice when I had gone half-way my research. I was told what to write by my supervisor. He said that the problem I would 'experience' was supposed to fit in what I had done at college. I had to fabricate some 'data' in order not to get at loggerheads with the supervisor. I needed the blessings of the supervisor."*

The traditional 'educators' who expose the learners to the non-active learning experiences are the disseminators of incontrovertible, static knowledge [3]. They have the conviction that learning is about absorbing vast bodies of processed knowledge. Thus according to these education traditionalists, it is not necessary to have the learners reflect on 'purified' knowledge that was generated by renowned academics.

Traditional education is considered to be non-educative on the grounds that it is detached from the experiences of the learner. Thus the methods of learning are foreign to the existing experiences and capacities of the learners [3, 45]. Informant 4 explained;

> *"I do not know anything about research methodology. The supervisor just talks about things that I do not understand. I am confused by everything."*

The quotation above implies that the learner just passes through the rhythms of the narrations by the 'educator' without any enthusiasm and not making any sense of the content [3]. Thus the non-active learning experience is considered to be undemocratic since it does not consider the interests of the learner and it separates the learner's experiences from learning.

14. Mis-educative experiences

Traditional education has been distinguished largely by its negative influences on future experiences [3]. The learners who experience traditional education are tied to subject-content without consideration of its relevance to real life [46]. Informant 2 postulated;

> *"I was given the research topic by the supervisor. The topic that I wanted to research on was brushed aside. The supervisor said that she had no time to grapple with a topic she was not interested in. I had to follow the interests of the supervisor for me to pass. My interests would not make me survive in this academic jungle. I was not motivated to do my research study."*

The learners who are exposed to the situation that is described by informant 2 lose "the impetus to learn" [3]. The experiences which the learner undergoes stifle the principle of continuity and are referred to by Dewey as mis-educative. A mis-educative experience obstructs growth for future experiences and also arrests or distorts growth [47]. After having gone through a mis-educative experience, the learner would not be motivated to be engaged in similar experiences due to the unpleasantness and/or meaninglessness of the experience. A mis-educative experience can be disjointed with the previous experiences and this makes the learners unable to make sense of future experiences [48].

A mis-educative experience can also be one that engages the learner into routine action which does not give room for new experiences [11]. The learner's environment becomes confined to the same things thus narrowing new and further experience. Routine action is repeated action which does not promote active learning for the broadening of the meaning-making horizon [10]. Confirmatory remarks were given by informant 4;

> *"The supervisor gave me a finished research project to copy from. He said that I would get a distinction if I would copy the project that he once awarded a distinctive mark. My conscience told me that I was cheating on myself."*

Similar remarks were given by informant 1 who postulated;

> *"It is some sort of a tradition that a research project is hard to complete without copying. I was told by my sister who is a teacher. My supervisor is not explicit about it but is implicit. She encourages me to get what I want from a finished research project."*

The supervisor who is a pseudo-educator gets the learner involved in vicarious experiences which are characterised by routine actions. The learner is alienated from his or her experiences to the extent of not being aware of the meanings that could be created from interactions with one's environment. Routine action makes learners unaware pawns in the midst of their own experiences [3]. The learners become enslaved in routine that any deviations render them the negative labels such as being dull or disobedient [11]. In order to avoid the negative labels, the learners become alienated from themselves and thus become prone to self-estrangement.

15. Educative experience

The principle of continuity also known as the experiential continuum embraces active learning and is one of the principal criteria for judging whether an experience is an educative one or not [3]. The principle is involved in attempting to assess the educational worthiness of experiences [3]. The criterion is manifested by the learner when he or she develops intrinsic motivation to continuous learning. Informant 5 expressed the principal of continuity by postulating;

> *"The problem that I am researching on is a result of my own experiences. The tuition that I am getting from the supervisor is meaningful since it is about a realistic problem. After my course, I will be able to carry out researches on my own to improve on my practice."*

In corroboration, informant 6 remarked;

> *"The relationship that I have with my supervisor is dialogical. The supervisor listens to my challenges and then suggests how I could surmount the challenges. I have been enlightened on how researches are carried out. I can do my own researches for professional development."*

Active learning is an educative experience which wards off complacency in the learner and instils an attitude of further exploration of the meaning of the present experience in connection with the past experience. The learner processes the data generated in the current experiences by using the meanings given by the previous experiences. Informant 7 explained;

> *"The experiences I got when I was doing action research have provided me with valuable knowledge, skills and attitudes to be continuously engaged in research in order to improve on my practice. I can make reference to my research findings when trying to solve similar problems."*

An educative experience is realised when there is reflection on the experiences and meaning is made. It is the meaning that the learner attaches to an experience which gives the experience some value. Informant 8 remarked;

> *"I experienced the problem that I am attempting to find a solution to. I am also experiencing the shortcomings of my practices in trying to solve the problem. I have since realized that I can improve on my teaching practices when I am introspective."*

16. Conclusion

Active learning in the teacher education curriculum is requisite in the construction of meaning from experiences. The learners are supposed to be engaged in reflective practice. The explicit realisation of the reflective practice in teacher education is in carrying out action research which entails reflection-in-action and reflection-on-action. Reflection is indispensable in active learning situations since it is the nodal point between past and present experiences. Any situation that stifles reflection on experiences begets non-educative and mis-educative experiences. According to the teacher education learners, the teacher educators who are traditionally oriented are pseudo-educators since they are responsible for the sustenance of traditional education which maintains the status quo. On the other hand, the learners who are exposed to action research are actively involved in professional development. The learners develop a disposition for open-mindedness and knowledge insatiability in their profession which culminates into life-long learning.

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Chapter 3

Usage-Based and Universal Grammar-Based Approaches to Second Language Acquisition

Kim Hua Tan and Vafa Shojamanesh

Abstract

The theoretical controversy that surrounds the acquisition of a second or foreign language is seemingly unending. Though there are dissensions in the literature, past studies had indicated that scholars tended to fall into two groups of schools of thought, the usage-based and the universal grammar-based approaches in second language acquisition. This paper reviews the literature of recently published findings in scholarly papers and contrasted the varied views of how second language can be acquired. Empirical evidence of both views are contrasted and discussed. Included in the discussion are environmental variables such as types of input and the length of input and non-environmental variables that are innate in learners.

Keywords: usage-based, universal grammar-based, second language acquisition, environment, innate

1. Introduction

Among the linguistic theories and approaches, the discussion of language acquisition and second language learning has been conducted for a span of a few decades by two groups of theorists: the Chomskyan linguistic generative structuralists and the functional psychologists' cognitive linguistics. Generative linguists believe in the existence of autonomous modules for language acquisition in the mind and claim that most of the grammar is not learned from the environment and communication, but arises from an innate universal grammar (UG). In contrast, functional theorists state that grammar is not transferable to the child or anyone else but arises from the functions of the language. Associating with the concepts underlying forms of a language, cognitive linguistics claims that knowledge of a particular language results from language use and that grammar is understood by conceptualization. Cognitive development includes all skills a child attains throughout his life. Cognitive skills matter because they lead to thinking and learning. Without skills such as remembering, numeracy, thinking, learning, reasoning, problem-solving, comparison-making, and decision-making, a child is at risk of falling behind. Cognitive developments matter from childhood to adulthood.

2. Usage-based versus universal grammar-based debate in second language (L2) acquisition

As two different approaches in theoretical linguistics, usage-based and universal grammar-based (UG-based) are two theories in language learning from various perspectives: the former focuses on the influence of experience, input, and frequency in language learning (i.e., cognitive linguistics), while the latter emphasizes the existence of an innate universal grammar and a set of rules as underlying basis for the formation of correct grammatical sentences (i.e., generative grammar).

Based on generative linguistics, language acquisition emerges from a combination of rules which will form grammatical sentences. Generative grammar (proposed by Chomsky in 1950s) arises from an innate universal grammar. Generativists believe that environmental input and language use has no effect on learning grammar. Taylor [1] further explains "acquisition, thus, became a matter of the 'setting' of 'parameters' provided by Universal Grammar, something which, it was assumed, would be possible on only minimal exposure to data" (pp. 573–4). Believing in the existence of an innate system of rules, generativists claim that universal grammar provides "the possible parameters for language and uses parameter-setting approach depending on which specific language is involved" (pp. 1141–2) [2]. It is claimed that language function is analytically separate from language structures.

UG-based approach claims that children have got a prior language knowledge "... which enables them to achieve an adult grammar on the basis of limited evidence" (p. 2) [3]. However, [3] points out, since 1990s, another model of input-driven approach was formed, usage-based theory of language learning, and it became so popular that UG-based approach was considered an outdated theory.

Aligning to cognitive linguistics, a usage-based linguistics (proposed by [4]) is "a form of linguistic analysis, that is, that takes into account not just grammatical structure, but that sees this structure as arising from and interacting with actual language use (p. 17) [5]. Based on this theory "... input is a rich source of information for identifying grammatical regularities and children have a remarkable ability to perform complex computations over statistical information displayed in the input" (p. 3) [3]. This theory argues that linguistic structures result from experience [6]. Tomasello [7] (as cited in [8]) states that language and language acquisition are usage-based and its structure emerges from using language.

Kang [3] points out that empiricists do not believe in the innate knowledge of language; supporting the input-driven language learning approach, they claim that language learning is based on sense and experience. They also state that child's input is systematic and regular which helps him/her to understand the system of the target language by the use of inductive reasoning. Frequency of language input is a major factor in providing the child with the information she/he needs in learning a target language: "...the more frequently a certain linguistic expression is available to the child, the easier it is for the child to learn it [9–12]" (p. 1) [3].

Kemmer and Barlow [13] also discusses two traditions that focus on language use that are usage-based: (1) firthian tradition, emphasizing on the role of context and social aspects, and (2) enunciativist linguistics, focusing on the speech act. "A Usage-Based model is one in which the speaker's linguistic system is fundamentally grounded in 'usage events' instances of a speaker's producing and understanding language" (p. iix) [13]. Langacker [14] (as cited in [13]) characterizes usage-based model with three features: maximality, non-reductivity, and being bottom-up. Accordingly, the mind is capable of analyzing complex structures in multiple ways, resulting in the production of both specific and general patterns through usage. The first two features imply the redundancy and massiveness of the grammar, and the

bottom-up feature determines that general patterns emerge from specific ones and specific patterns are the result of experience.

As [13] points out, usage-based accounts are experience-driven, and frequency of items is an important factor and an inseparable part of language learning, especially in forming and understanding structures and operations; "… Usage-Based events play a double role in the system: they both result from and also shape the linguistic system itself in a kind of feedback loop" (p. viii). In usage-based accounts, language is learned by data observation in the actual use of language. From Langacker's [4] viewpoint, in usage-based model "substantial importance is given to the actual use of the linguistic system and a speaker's knowledge of this use; grammar is held responsible for a speaker's knowledge of the full range of linguistic conventions (p. 494)" (p. 2) [13]. Kemmer and Barlow [13] claims that "through repetition, even a highly complex event can coalesce into a well-rehearsed routine that is easily elicited and reliably executed" (p. 3).

From Croft's [15] point of view, in usage-based models language use specifies grammatical representations: "the Usage-Based model is a model of grammatical representation in which language use determines grammatical representation. Specifically, frequency of use and similarity of form and meaning are the determining factors for the structure of grammatical knowledge in the mind" (p. 499). According to Langacker, usage-based model "focuses on the actual use of the linguistic system and a speaker's knowledge of this use …, it claims that linguistic units are abstracted from usage events, that is, the actual instance of language use" (p. 1142) [2].

In usage-based models, frequency of usage plays a big role in the production, language comprehension, and grammaticality of the patterns. The two mentioned types of frequency are token and type frequency. Token frequency "is how often particular words or specific phrases appear in the input" (p. 166) [16]. As [15] defines "Token frequency is the frequency of occurrence in language use of individual tokens of a grammatical type, such as English regular past tense forms" (p. 499). Quoting from [15, 17] states that how much a form like irregular word forms entrenches in the learner's mind is a token frequency function. Type frequency is defined as "how many different lexical items can be applied to a certain pattern, paradigm or construction" (p. 166) [16], or it is referred as "the frequency of word types that conform to a schema" (p. 499) [15]. The regular past inflection is mentioned to have high type frequency because it is applicable to a large number of different verbs [15, 16].

According to [18], usage-based approaches are input-dependent, and in this theory, "frequency" is considered as the language rule which results from structure analysis in language input. Zyzik [18] states that there must be enough input so that the learner can learn whatever she/he needs: "… it must be abundant enough for the learner to abstract regularities from concrete exemplars of language use" (p. 54), such as native competence which is gained after lifetime attention to the L1 input. Ellis [16] (cited in [18]) points out that in order to achieve native fluency at the L2, there must be huge amounts of language input so that the learners can choose and analyze the words and sequences they prefer. In input-based accounts, children are expected to follow input patterns by experience and environmental effects [19], and the grammatical relations result from the co-occurrence of language functions and forms [20].

Zyzik [18] also states that based on usage-based theory, insufficient input and little access to abundant and implicit input like L1 are the reasons that ultimate attainment cannot be achieved by L2 learners. She points out that "lack of exposure to sufficiently rich and varied input" (p. 56) is the cause of poverty of stimuli. She

mentions that very few studies have been conducted on the quality and quantity of input in instructed settings. She claims that with the help of input frequency, the L2 learner should be able to pick up the abstract regularities from the exposure to the abundant and rich input. According to her, in SLA settings, high-frequency items (i.e., the forms and structures that abundantly emerge in the language input) cause no learning problems; the focus should be on the low-frequency forms in the input.

There is this conflict between the supporters and the opponents of these two approaches (i.e., UG- and usage-based) whether language learning is done on the basis of the input exposure and experience or by the help of the innate knowledge of learners, and still it is not clear whether grammatical learning is usage-based.

3. Theoretical applications of usage-based versus universal grammar-based approach: Some empirical evidence

There are a number of studies that contrasted usage-based and UG-based conditions in empirical studies.

To compare usage-based and UG-based approaches, Kang [3] studied scrambling and multiple nominative case marking as the two syntactic structures among Korean children. The results of his study showed that child's speech to a great extent resembles adult's; both mentioned structures were used very little in the children's speech because their frequencies in parents' speech were low which shows that child's grammar is a reflection of the adult's. This frequency match between child and adult's speech supports the input-driven approach. But examining the same idea in the experimental group showed that though scrambling was absent in the children's input, it was eventually used and learnt, and this rejected the role of input-driven approach. Hence, [3] proposes the existence of an innate knowledge among children which is in support of the UG-based approach.

To delve into the acquisition process in the two theories of UG and usage-based theory, Zyzik [18] studies some problematic linguistic structures in both first and second languages (such as want-to contraction, yes/no formation, and pronoun interpretation) and synthesizes some input constructs (such as frequency effects, the poverty of stimuli, and other cases). According to her, input is not enough for learning some complex structures. In addition to input, learners must have grammatical competence ("innately intuitive knowledge"). She says that learners cannot gain ultimate attainment when the input they receive is impoverished or insufficient. Then by rejecting the poverty of stimuli idea of the usage-based theory, she concludes that "...the input is rich enough for children to acquire all the properties of language if mechanisms such as item-based learning, competition among forms, indirect negative evidence and sensitivity to frequency are given serious consideration" (p. 57). She proposes UG-based as competing approach in the L2 acquisition.

Rothman and Guijarro-Fuentes [21] studied the role of input quality in naturalistic (UG-based) and instructional (usage-based) settings. They state that there is a difference between age of acquisition and the critical period hypothesis. At the age of acquisition process, the focus is on input. Since input causes acquisition, when to be exposed to the significant input is of great importance. They point out that there is a correlation between age of exposure to the native input and age of the first significant exposure, no matter whether the input comes from a naturalistic or instructed context.

Rothman and Guijarro-Fuentes [21] further states that clearly learners in L2 instructed settings receive less amount of input than those who are learning the target language in a naturalistic language learning setting because in naturalistic settings, learners have access to the native speakers outside the class. Thus, as they claim, the

quality of input is introduced as one of the main variables which shows the differences between the two learning settings: different amounts of input result in different competence outcomes. However, as they claim learners in instructed settings receive better input quality; the input includes syntactically, semantically, and morphologically accurate structures, while in naturalistic settings learners receive nonstandard input. This highlights the importance of the instructed input in formal classes in foreign language learning settings. They point out that some of the linguistic properties are not acquired from input due to the poverty of the stimuli. These properties are obtained by language universals. Another point raised is that in instructed language learning settings, teachers themselves are L2 learners which are very common in non-English speaking countries. They emphasized that age of acquisition is neglected among different variables in adult language acquisition. It is decided that input quality causes differences in naturalistic and instructional settings.

Francis [22] investigated the role of the foreign language learners' attention and awareness on their language acquisition. He considered one of the input enhancement techniques, "input flooding", which bombards learners with great amounts of target items. It was used to explore the extent of the acquisition of two of the copulative verbs in Spanish. The participants were divided into experimental and control groups and were tested by these tasks: grammaticality judgment, written production, and picture description. T-tests were used for analyzing the data, and the scores between and within groups were compared. Data analysis revealed that input flood had no significant effect on the acquisition of the two mentioned verbs. He believes that to come to a final conclusion, the input flood on the acquisition of these two verbs was not sufficient. It is suggested to consider simple structures in input flood and in longer treatment periods; being exposed to more structures of the target forms can make a big change on the effect of the input flood on the learners' proficiency level.

Yet another study contrasted UG-based and usage-based in the case of [23] where she studies the correction feedback in L2 speech production from the viewpoints of the two opposing theories: cognitive-interactionist and nativist. According to nativists, language acquisition device (LAD) is inherent in all human beings, and positive evidence is vital for studying the development of a second language. Nativists believe language acquisition is purely implicit, and by corrective feedback learners are informed which structures are unacceptable, while according to cognitive interactionists, learning is both explicit and implicit, and "the information obtained through feedback may serve as input data for explicit rule-learning or subsequent implicit learning" (p. 2) [23]. Li discusses different ways of error correction and defines explicit correction and recast as the 'input-providing feedback', while repetition, elicitation, metalinguistic clue and clarification are identified as 'output-prompting feedback'. In conclusion, [23] provides useful types of feedback to the teachers; for teaching new linguistic structures, input-driven feedbacks such as recasting is suggested, while in teaching previously learned linguistic structures, where deep cognitive processing is involved, output-prompting feedback like self-correction is recommended.

Nativists and cognitivists could not provide sufficient evidence and proofs to specify which approach controls syntax acquisition process, so in [24], Al-Balushi presents a new avenue. He claims that looking at the syntax acquisition from second language learning perspective shows the accessibility of UG by adult L2 learners by using analytical and verbal abilities. He suggests researchers examine the structures and constructions which are neither found in the learner's L1 grammar nor in L2 input. Then it would be easier to find out whether learners' performance is based on experience or not. As [24] addresses, there are still remaining questions about the involvement of UG in language acquisition process and its extent. The role of linguistic data or language input in language acquisition and whether UG can be

a compensation for the impoverished input are the topics yet to be studied and investigated.

In a study by [24] on child language acquisition process, it was further discussed that children use strategies, mechanisms, and pragmatic inferences to comprehend lexical symbols of adults. As he points out, cognitive and social processes both assist children because there are similar semantic relations (like action and agent) in all cultures. Exposure to linguistic input enables children to formulate word classes of nouns and verbs in positions they have not experienced before. As a result, cognitivists believe language is acquired by more cognitive components. However, since the language of a child is a reflection of caregiver or experimental learning situations, syntax acquisition can be referred to usage-based and experience-based approaches [24]. This has implications on future research in second language acquisition.

There are various studies relating to input exposure and effective factors in second language learning and acquisition. The next section is a review of studies focusing on the effect of early input, the effect of late input, and the effect of environmental input.

3.1 The effect of early input in second language acquisition

Some researchers believe that receiving language input at an early age has positive effects on the learning process. Borovsky [25] believes that early language input has a great influence on increasing lexical proficiency level and having less linguistic input exposure causes learning problems. She states that because of the effect of receiving early input, cognitive mechanism of children is different in the word learning process; children find the relationship between words and their usage by the use of categorization. She also mentions that an increase in the linguistic input has a positive effect on the children's vocabulary learning process.

Kharkhurin [26] hypothesizes that in the early years, cognitive process of the bilingual children causes mental construction which results in cognitive advantages later in their lives. When a target language is learnt early, better underlying concepts are formed, and there will be a better relationship between learner's linguistic and conceptual knowledge.

Huttenlocher et al. [27] points out that normal children learn basic syntactic structures at early ages, but there are variations in the rate and course of acquisition especially when the structures are more complex. They also mention that there is a relation between language input and learners' skills in some parts of syntax. They hypothesized that some skills which were not related to language input at early ages can be influential later.

It is believed that when the L1 is more established at the time of first exposure to the L2, it will interfere more with the L2 production. Flege [28] (as cited in [29]) states that the problems that adults encounter in the learning process is not because of "normal neural maturation" but because of the L1 interference. Iverson et al. [30] (as cited in [29]) mentions when the L1 becomes more developed, the learner faces more problems. So they suggest an early start of the L2 because till L1 categories are not fully established, the L2 learner will have an easier learning process.

Krashen et al. [31] (as cited in [32]) claims that starting younger makes learners more successful and can result in native-like performance. Nevertheless, as they mention, late learners learn faster.

3.2 The effect of late input in second language acquisition

Munoz [33] states that since late starters have a faster rate of development, further exposure allows them to catch up with the early starters especially regarding

literacy-related skills. Late starters achieve similar proficiency levels in shorter periods of time.

Frediani [34] studied the effect of the age of onset and the amount of instruction on EFL learners' proficiency in Argentina. 7–8-year-olds were compared with 12–13-year-olds. Considering the instructional time, the study shows that though late starters had fewer instruction hours, their cognitive maturity helped them to overcome the problems in language learning.

3.3 The effect of environmental input in second language acquisition

It is believed that being exposed to the target language outside the formal situations influences the learning process. Borovsky [25] states that early linguistic experience of children at home is correlated with their linguistic input ability at school: when their home environment is linguistically enriched, they learn new words faster.

The results of the study by [27] show that child's syntax is highly related to the input variations; there is a critical relationship between teacher's and parents' syntactic input and child's syntactic growth. The effect of the teacher's input is significant not at the beginning of the school year, but over the years, and those who provide language input for the child as a learner play a big role in the learning process of syntax. They found individual differences between children's skills and a correlation between these differences and parents' complexity of speech.

Aukrust [35] states that "children can and do learn language as well as other socio-cognitive skills from keenly observing the interactions of others and listening in on talk" (p. 18). Beals [36] (as cited in [35]) points out that children whose mothers used more words in conversations had a bigger size of the vocabulary.

A brief look at relevant studies to input exposure as most studies indicated usage-based has significant links to second language acquisition.

3.4 Summary of related studies on input exposure

Title	Author(s)	Results
The effect of early input	Borovsky [25]	Early language input has a great influence on increasing lexical proficiency, and less input causes learning problems
	Kharkhurin [26]	By learning a target language early, underlying concepts are formed and a better relationship shapes between learners' linguistic and conceptual knowledge
	Huttenlocher et al. [27]	There is a relationship between language input and learners' skills in some parts of syntax
	Fledge ([28] cited in [29])	Adults' learning problems are because of L1 interference
	Iverson et al. ([30] cited in [29])	To have an easier L2 learning process before L1 categories are fully established, an early L2 start is suggested
	Krashen, Long, and Scarcella ([31] cited in [32])	Starting younger makes learners more successful and can result in native-like performance
The effect of late input	Munoz [33]	Since late learners have a faster rate of development, further exposure allows them to gain better literacy skills in shorter periods of time
	Frediani [34]	Late starters, with fewer instruction hours, overcome language learning problems because of their cognitive maturity

Title	Author(s)	Results
The role of environmental input	Borovsky [25]	A linguistically enriched environment helps learning new words faster
	Huttenlocher et al. [27]	There is a critical relationship between teacher's and parents' syntactic input and child's syntactic growth which arises over years
	Aukrust [35]	Children learn language like other socio-cognitive skills by observing and listening to the interaction of others
Age influence in language learning	Penfield and Roberts [37]	Language learning is under the influence of an influential period in early childhood called critical period (i.e., CP)
	Bettoni-Techio [38]	There is no fixed agreement on the onset and offset of language learning, but puberty is the offset
	Perani et al. [39]	Age is an influential factor in language learning, and late learners are less proficient than early ones
	Singleton [40]	Native-like level can be gained before age 7
	Dimroth [41]	Starting at lower levels in primary schools is suggested to increase better learning/acquisition attainment.
	Larson-Hall [42]	Early starting age can be advantageous only if individuals acquire a significant amount of input
	Huang [43]	Learners' first exposure to English and school teaching time is significantly correlated with their accuracy of the studied vowels. In addition, the formal instruction of English at an earlier age is suggested
The ineffectiveness of critical period	Munoz ([44] cited in [42])	No advantage for earlier starters was observed in this study; attitudes and motivation were the only advantageous parts for early starters
	Bialystok and Hakuta [45]	Older learners transfer more than younger ones, and they can gain native-like attainment
	Slabakova [46]	Critical period has no effect on semantics
	Burstall ([47] cited in [42])	No effective age influence was found on the performance of early starters in this study

Language input has been studied from various perspectives to clarify its role in the teaching and learning process so that better learning contexts will be provided for language learners. The amount and length of receiving linguistic input can have a determining role in better learning, especially in foreign language settings that are mostly input-dependent.

4. Conclusion

There is tension between the supporters and the opponents of these two approaches (i.e., UG- and usage-based) on whether language learning is done on the basis of the input exposure and experience or by the help of the innate knowledge of learners, and still it is not clear whether grammatical learning is usage-based or universal grammar-based. What is certain, at this juncture, is that it is worthwhile investigating the following parameters and variables: the role of different types of frequency of L2 input (such as type and token frequency), the role of L1 transfer, the impact of L1 frequency on the learners' performance data, L1 and L2 co-occurrence probabilities, the interaction of the L1 in L2 input, and the impact

of L1 on L2 proficiency levels. For reliable results, learners should be selected from different age groups and language learning settings (both second language learning settings and foreign language learning settings). It cannot be overly emphasized that sufficient numbers of participants should be considered for these studies as well to have valid outcomes that can be applicable to other contexts and situations. These considerations will certainly help scholars in the pursuit of an answer to the usage-based or universal grammar-based debate. On whether the success of second language acquisition is a result of the innate knowledge or is a result of usage-based experience, the positive effect of the length of exposure shows that grammatical learning can be claimed to be usage-based, but further research by larger groups of learners with early exposure are needed to support this.

Acknowledgements

We would like to thank the Malaysian Ministry of Education for providing the financial support for the research and authorship of this article. Research grant coded FRGS/1/2018/SS09/UKM/02/.

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Chapter 4

Non-Formal Education as a Foundation for Active Learning

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Abstract

This chapter will include several examples of how non-formal education serves as a foundation for active learning. It will relate how non-formal education organizations such as the scouting movement through the World Organization of the Scout Movement (WOSM), works to engage young people to be developed holistically. It will also mention non-formal active learning strategies and their relation to semiotic and esthetic stimuli. The role of semiotics in non-formal active learning will be exemplified, and the article will mention how self-commitment may be created when using non-formal education and active learning. Finally, it will be discussed how dialogism takes part in this process.

Keywords: non-formal education, active learning, semiotics, aesthesis, dialogism, embodied cognition, scouting, scout method

1. Introduction

The traditional Socratic method (method of Elenchus), has been a form of cooperative argumentative dialog used at learning institutions to stimulate critical thinking for many years. With the development of new technologies in the past 100 years, teaching and learning methods have evolved to add new perspectives and theories. These events have caused lecturers and students to become more active and participative, creating new ways to interact. Nowadays the learning process includes active learning to avoid students receiving passive information that does not relate to their needs. There are considerable studies involving formal education and active learning, but in the case of non-formal education, the information is more limited.

The chapter will describe how non-formal education is used to achieve active learning. The scouting method will be explained and discussed since the scouting movement is the largest youth non-formal active learning community in the world. Subjects such as how semiotic take an important role in this method will be mentioned, and also how the scouting movement uses esthetics and dialogism to achieve the scout's (learners) development goals.

2. The evolution of non-formal education

Non-formal education has been described [1] as a flexible education process with a defined methodology and most important, capable of adapting to the needs

and interests of students. In this kind of process, time is not a pre-established factor because it is defined by the student's pace, and it does not seek to provide a formal certification or scholar degree.

To understand the development of non-formal education, it is required to describe formal and informal education. Formal education is a model that has a systematic organized and structured curriculum, which is rather rigid. This process necessarily involves the presence of a teacher, a student, and an institution. Educational institutions administer the curricula and the final goal is to provide some kind of certification or degree [1].

Informal education, on the other hand, has no defined structure, it has no curricula and it takes place through experience. It consists of accidental or purposeful ways of collaborating with other persons and acquiring new information and everyday skills [1].

In the beginning, the boundaries between formal, non-formal, and informal education were well defined, but changes are being made due to the COVID-19 pandemic and the normal method evolution. Formal education has adopted non-formal methods to solve some of the online demands of students. At the same time, non-formal education is now using assessment recognition programs (ARCNIL) to get a certification. Svetlik [2], relates that non-formal education has become a social issue. It is mentioned that in order to achieve a more efficient knowledge transfer, formal education has become increasingly dependent, and organized. Non-formal education provides relief of bureaucracy issues. Additionally, non-formal education provides knowledge, but the formalization requirements have increased due to the demand for qualified employees. This has led in some cases to the need of creating some sort of certification for this process.

New knowledge demands require internal labor, and training markets allow the development of individuals with knowledge and skills as core workers. Organizations have established training using non-formal methods that transfer knowledge, and most important "skills" to workers. Svetlik [2], mentions that the assumption that formal knowledge and training could fluently bring formal curriculum and convey students, has been misled. It is argued that this is because teachers tend to overlook interdisciplinary knowledge. There might also be communication barriers between schools or researchers, also some companies might resist sharing firm-specific knowledge to preserve a competitive advantage. Polanyi, 1996 cited by Svetlik [2] mentions: "it is difficult to express a great deal of knowledge in an explicit form, and convey it with school teaching methods" Ideological biases and blindness can also be experimented by formal curricula. Finally, access to certain information can remain restricted due to a limited number of participants.

The information presented so far, leads to believe that formal education must be complemented with non-formal education, to seek not only knowledge but the development of real-life "in situ" skills. Since non-formal education is based on "learn by doing" it develops real-life skills by allowing participants to experience their learning, this is where active learning becomes an important factor for knowledge to take place. To exemplify the relation between non-formal education and active learning, this chapter will describe concepts as they are applied in the World Organization of the Scout Movement (WOSM), which is the largest non-formal education organization in the world.

3. Non-formal education and active learning

Due to the problems of strategies that formal education programs may experiment to accomplish an integrated formation, non-formal education has been essential.

Educational institutions or other types of organizations, favor goal achievements in different areas to contribute to self-realization of the individual.

Nowadays, young generations have a lack of motor, emotional, and social skills. It seems they are more aggressive, anxious, dependent, and less creative [3]. These are some of the reasons why it is imperative that children, adolescents, and young adults are submerged in extracurricular activities. These activities not only give them tools for life, but they also contribute to the awareness of their learning process, so it can be applied in a formal-educational environment.

3.1 Active learning

Learning is a process that implies the way in which people acquire knowledge, or modify the knowledge and skills they possess, in order to improve their task performance [4]. It is an active mechanism that depends on the learner's cognitive activities. It is facilitated by the analysis and reformulation of previous knowledge, and it results from the interaction and adaptation with the environment, in order to get holistically integrated into the world [5].

The Experiential Learning Theory described by Kolb, D. in 1984 [6], enhances the role of experience in the learning process, and its transformative power to create knowledge. It complements the benefits of active learning since the latter is defined as an engagement of activities to assess people's understanding and skills. This enables them to handle a particular situation, and keep active in their learning by evaluating, analyzing, and taking action [7]. In this manner, it is important to acknowledge the benefits of deep, meaningful learning, facilitated by this process, since it is a more effective means of education.

4. Scouting in education

Scouting is a worldwide movement that involves more than 50 million people, distributed in over 200 countries and territories. It is the biggest youth organization in the world, and its mission is to contribute to the self-fulfillment of individuals in order to help them play a constructive role in society [8]. This is made possible by the implementation of a non-formal education process that helps develop capabilities throughout life, in order to make autonomous, supportive, responsible, and committed individuals [9]. Although in some countries or territories, scouting is not necessarily related to academic activities, in some places, scouting is part of the extracurricular activities of elementary (elementary school), secondary (junior high school), and high (senior high school) [10–12].

Today its educational program involves the holistic development of the children, adolescents, and young adults in six basic areas: affectivity, character, creativity, sociability, physical conditioning, and spirituality. Affectivity development is gained by the exploration, identification, and management of emotions, as well as the recognition of their wise use of liberty. Character growth is related to their ability to be congruent with their principles and values. Creativity is obtained through imagination, finding different routes of problem-solving, innovating, project development. In general terms, practicing their thought process. Sociability is developed by solidarity, meaning the identification of common interests and goals through empathy, thus creating a sense of belonging to a social circle. Physical conditioning involves not only the practice of physical activity, acknowledgment of the individual's limits, and general good health habits, but also contact with nature. This is a very important part of scouting, since it encourages to appreciate the environment's resources, and how to respect and use them intelligently. Spirituality is gained by

the identification of self as a small but important part of the world, creating a sense of inner peace and peace with others.

Since the foundation of the scout movement over 110 years ago, the educational program has evolved to attend the youth's needs, adapting itself to fulfill the requirements of the constantly changing generations. Nevertheless, the way that the program is implemented is based on a system that has been essentially the same since it was originated, and it is key to the organization's success: the scout method.

4.1 The scout method as a way of active learning

The scout method (SM) is defined by the WOSM as a "system of progressive self-education activities". It is based on the interaction of equally important elements that work together as a cohesive system. The elements are:

1. *Community involvement:* Active exploration and commitment to communities and the wider world, fostering greater appreciation and understanding between people.

2. *Nature:* Learning opportunities in the outdoors encourage a better understanding of the relationships with the environment.

3. *Learn by doing:* The use of practical actions (real-life experiences) and reflection(s) to facilitate ongoing learning and development.

4. *Symbolic framework:* A unifying structure of themes and symbols to facilitate learning and the development of a unique identity as a Scout.

5. *The scout promise and law:* A personal voluntary commitment to a set of shared values, which are the foundation of everything a Scout does and wants to be. The Promise and Law have a central role in the Scout Method.

6. *Personal progression:* A progressive learning journey focused on motivating and challenging an individual to continually develop, through a wide variety of learning opportunities.

7. *Adult support:* Adults facilitating and supporting young people to create learning opportunities, and through a culture of partnership to turn these opportunities into meaningful experiences.

8. *Team systems:* The use of small teams as a way to participate in collaborative learning, with the aim of developing effective teamwork, interpersonal skills, leadership as well as building a sense of responsibility and belonging.

Felder & Brent [13] mention that active learning is a way in which participants assume a dynamic role. They retain more knowledge when they experiment and reflect than just receiving passive information through their senses. Active learning takes time since participants are expected to take action, demonstrate, make models or review information, and finally review their findings.

The SM encourages participants to take an active role, develop skills, work by teams, learn by doing, and most important to make a self-commitment. This aspect becomes fundamental since participants oath to do their best. This concept reinforces active learning since it is the active learner who seeks to develop his full potential.

Another fundamental issue is the work of small groups, young people get to create their own natural team in which they are all friends and each scout has the opportunity to become a leader. These friendship bonds usually last a lifetime since they do not form regular teams as in in formal education. Scout teams called patrols, live experiences that mark them for life, and the stronger the experiences, the stronger the bond that unites them. The patrol becomes the fundamental place in which active learning takes place, they decide which activities to do and ask the adult leaders to help them reach their goals. Patrols interact with each other and constitute a troop and the adults only act as facilitators and advisors for their activities.

4.2 Scouting contributions to the United Nations 2030 agenda

WOSM has been exploring international development programs in which scouts have been earning Badges by developing projects that are created to solve the needs of the communities where they live. These programs are called "Better World framework". It's based on the United Nations Sustainable Development Goals (SDGS). UN [14] states "The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace, and justice."

WOSM is part of the United Nations (UN), therefore the adoption of these goals was an organization prerogative. This action created a worldwide active learning community in which youngsters collaborate in a very dynamic way with scouts from other countries. Global awareness became evident and the following international programs were created:

- *Messengers of peace.* It's a scouting initiative, which encourages scouts to do community service and tell the story of their experience in order to inspire others.

- *Scouts of the world.* Scouting encourages young adults to take action by learning about local problems, creating a service project, and then taking action in the form of voluntary service.

- *Dialog for peace.* By recognizing that the world is diverse, the scouting movement encourages scouts to learn to find similarities unnoticed before and even come to respect and sometimes appreciate differences to find inclusive solutions to shared problems.

- *Interreligious dialog.* This program shows scouts that each form of religion must be respected and its active practice encouraged, scouts may have the opportunity to develop the spirit of mutual goodwill and understanding.

- *Scouts Go Solar.* It's an initiative that shows scouts how to harvest solar power and seek to use natural sources of energy.

- *The World Scout Environment Program.* It has been designed to provide scouts with environmental awareness and take action to connect with nature in order to stop pollution and protect the planet.

- *UNESCO World Heritage Recognition.* It's a program that seeks to recognize scouts that promote sustainable development actions.

- *He for She Program.* This program sponsored by the UN teaches scouts that women and men are equal and fundamental to achieve gender equality and allow women empowerment.

4.3 Challenges in the implementation of an educational program

Scouting experience in different parts of the world is unique. The culture, economic, social, and security status, influence the ideal execution of the program.

Culture plays a transcendental role since not all educational objectives can be developed in the same manner, in countries that have distinctive sets of values, traditions, and customs. Even in the same country, language and family dynamics in different ethnic groups can influence the capability of developing certain goals in an area of interest. This is balanced by the program adaptation in conditions where the culture is not only respected but promoted as well. In many cases, economic status determines the permanence in the movement, where the administrative and operative activities have a cost. As with other institutions, membership fees are adjusted according to budgets, and economic strategies at different structural levels of the institution are suggested in order to minimize the financial burden. Social status, determined by the relationship between people of a broad spectrum of ages and genders, influences their capability of being involved in decision making and their opportunities to develop leadership skills. From the moment their cognitive abilities provide a sense of judgment on the youth, their participation in decision making organs is promoted and guided by the adult volunteers that facilitate their education. Nevertheless, there are still areas of opportunity, inequality is still present in different facets since it is a condition in evolution all around the globe. Security status affects the decision-making process. An inadequate satisfaction of basic necessities such as food and health sets aside the educational activities or modifies their application strategies. A practical example is a condition derived from the Covid-19 pandemic, where in the best-case scenario, people have to adapt to an online environment in order to carry on their education. But since there are areas of personal growth that involve social interaction and physical contact, the program execution gets compromised and it's more difficult to deliver.

The holistic character of scouting is determined by the growth of different areas of the being. But since its educational program is a balanced set of activities within and outside the scouting environment, there is much to consider in terms of its effectiveness influenced by the social and physical environment status.

5. Semiotics, non-formal education, and active learning

Friedman & Thellefsen [15] define semiotics as a way to represent knowledge using symbols, this refers to the production and conversion of meaning through the use of ideograms, images, or symbols. These authors mention that there are several systems used to organize and represent knowledge. They imply that a symbolic language may fulfill the following roles:

An interpretative approach, in which each individual might attribute meaning to a symbol by making a correlation between the symbol and some relevant event. This might include a socio-cognitive approach, semiotics, and pragmatics.

A descriptive/objectivist approach, where the learning process is guided by a facilitator and might include cognitive science, linguistics, and concept theory.

Non-formal education as it is used by the WOSM, uses both of the previous roles with one difference.

The objectivist approach defines the use of specific symbols that transfer knowledge. The meaning of these symbols has been defined by scouting authorities. Since non-formal education as used by the WOSM, has very well-defined educational goals, "badges" have been developed by National Scout Organizations (NSO) around the world to be awarded to youngsters that have achieved an educational

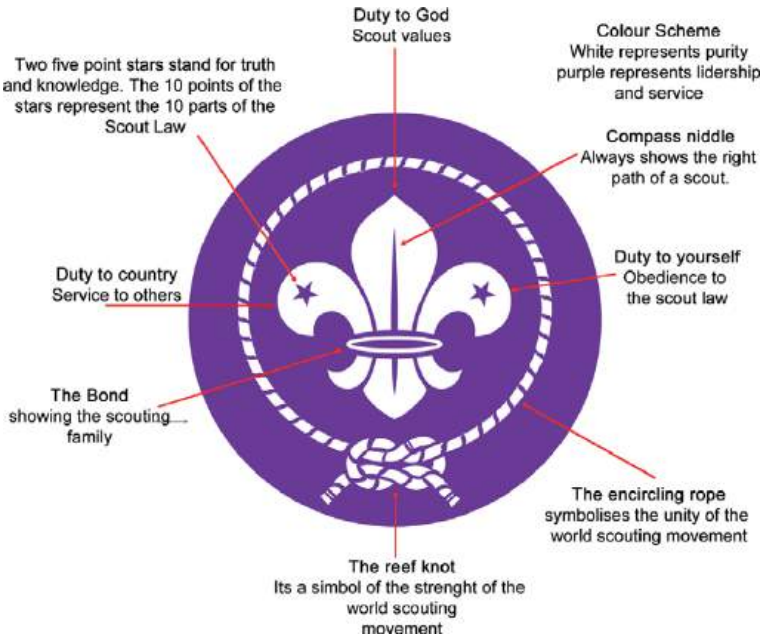

Figure 1.
World scout emblem explained. Copyright WOSM.

objective. This badge is the formal recognition of achievement by the NSO and it is known by the international scouting community. This acknowledgment represents an extra stimulus on the youngster and reinforces the non-formal knowledge acquisition process. The objectivist approach defines the extrinsic representation of the badge. The rules that the youngsters need to comply with to get this badge and the acquaintance that young people are expected to have.

The interpretative approach represents the intrinsic meaning of the achievement. This is one of the most important tools of non-formal education, that has been implemented by the WOSM. Most of these achievement badges are delivered in a ceremonial environment which adds meaning to the occasion. Complex symbolic frameworks are created so youngsters receive an unforgettable ceremony. In this process, the personal esthetic meaning gets added to the learning experience.

The perfect example of semiotics it's the world scout emblem (fleur de lis) it is worn by scouts and scout liders around the world to indicate their membership. The Scouting movement founder, Lord Robert Baden Powell of Gilwell, selected this emblem (**Figure 1**) to represent scouts around the world.

As you can appreciate, the world crest is an ideogram that receives an interpretative approach, this interpretation changes depending on which national scout organization uses the emblem. In Latin America National Scout Organizations, this crest also represents the scout oath, and the meaning attributed to it does not represent only an objectivist approach but it goes much further since it becomes enriched by an interpretative meaning often surrounded by an esthetic environment.

6. Esthetics and non-formal education

Casey, et al. [16] mention that an esthetic experience is lived and felt individually, and it relates to a sensory experience in which the person establishes beauty standards. It is a process where the esthetic object exists to be perceived by the audiences. Spectators become witnesses of various forms of sensory data input that

is found pleasing to the senses. The important part is that each esthetic experience gets completed only in the consciousness of the spectator, it is an active perceptual engagement between the object and the spectator. It is the personal perception, reflection, and feelings of the person who is experiencing the esthetic phenomenon.

Non-formal education as applied by the WOSM provides designed environments to exploit subjectivity. This allows the viewers to become an active part of the action, favoring the appearance of feelings that will be processed by the participant as embodied cognition. This will allow the youngsters to include high-level mental constructs and perform various cognitive tasks that will add personal meaning to the occasion. The SM gets enriched when youngsters not only get recognition for their work but also create personal bonds with other scouts and develop feelings associated with the events in which they were immersed.

Added esthetic value can be found not only in the meaning of the badge given to the youngsters but also by asking their loved ones to be present. In this way, family and friends can be present throughout the entire educational process and provide continuous support.

7. Dialogism and how non-formal education helps

Jamail-Nesari [17] cites Bakhtin, M. when he defines dialogism as the process in which meaning is evolved out of interactions among the author, the work, and the listener. These elements are affected by the contexts in which they are placed. Bakhtin argues that understanding cannot be reached if a monologism approach is used, since it will only show an objectified world that corresponds to a single and unified consciousness. Bakhtin comments that monologs turn off the process of dialog, but are often used by formal education as the dominant approach for educational situations since education cannot be purely monological because there is always another perspective present in the classroom. Bakhtin proposes a different approach called Dialogism.

Jamail-Nesari [17] mentions that dialogism is a model of conversation used to practice speaking and provide examples of language usage. Bakhtin cited by Jamail-Nesari [17] proposes a different meaning for dialogism. It is mentioned "Any utterance, whether spoken or written, that people use in communication with each other is internally dialogic". For Bakhtin dialog exists not only in spoken words but also in all sorts of expressions, movements, and interactions made to communicate information. Bakhtin proposes that dialogism is a process in which all participants must communicate with each other, there is always room for arguing because dialogism seeks that every person expresses a point of view. This process allows a great deal of freedom for interaction among participants, Bakhtin called this process polyphony (multivoicedness).

Non-formal Education as used by WOSM develops polyphony on different scales. The first one and most basic is when the youngsters get to pick their small group (part of the scouting method). Scouts not only choose their team but also their leader and the rules of their patrol, this is done eminently through dialog. Youngsters assign a formal definition of the duties of each member and seek to fulfill them at any time (meaning that scouts will always try to follow the scout principles). This is where most of the active learning occurs, right inside the smallest group, because each patrol member must work directly with other members to develop projects and seek to enhance their knowledge of various subjects. The next level called council level is where different groups get together in a specific region. At this level, Polyphony is worked in a different way through the use of youth forums, in which youngsters get selected by their scout mates to represent them.

In these forums, scouts learn about current topics and develop communication skills with adults and other scouts from their region. National forums occur once a year, selected youth participants initiate different communication protocols, they also discuss the problems they are facing and how to solve them. Finally, every four years the biggest scout event in the world unites scouts from over 250 countries and territories to experience the ultimate polyphony discussion. In the World Scout Jamboree, thousands of youngsters get together and adopt the model of the UN to work on the problems their communities and the world are facing. Some topics are decent labor, rights of persons with disabilities (inclusion), human rights, environmental actions, migrants and refugees, gender equity, youth, peace, and security. Each scout representative gets selected to speak about his own country and all the opinions, and conclusions are collected by the WOSM and then shared with the NSO and other institutions that express interest.

8. Active learning, semiotics, aesthesis, dialogism, and non-formal education a case of study

WOSM has been divided into six regions worldwide, different actions have been taken by all these regions due to the COVID-19 pandemic.

As the pandemic was unexpected, many countries were unprepared to deal with the requirements and the coordination needed to overcome this disease. In response, every NSO started to involve scouts to respond actively to the needs of the community. Several examples of the Better World Framework projects will be mentioned below, with emphasis of the ones developed in the Asia Pacific Scout Region.

Afghanistan scouts created public awareness campaigns through the distribution of flyers and social media. Older scouts participated in the disinfection of public spaces, vehicles, residential areas, and orphanages. They also helped with the distribution of food and hygiene packages to families facing starvation due to the lockdown. Additionally, entire scout families got involved in sewing and distribution of face masks to police and medical personnel [18].

Scouts from Bhutan have done several health awareness actions, giving information to the communities, preparing postcards for handwashing and general prevention Covid 19 prevention messages, to assist in breaking the chain of transmission. Also, generating spaces of experience sharing after illness, in order to help psychological health, and volunteering to do Covid 19 surveillance duty with school teachers and general public [18].

Scouts from India distributed masks and sanitizers in their communities, organized rallies, door to door campaigns and graphic material for Covid and good health awareness, and posters for local commercial prohibiting entry without masks. They also made food distribution programs for people in need derived from the pandemic, as well as for street animals [18].

In Cambodia, scouts raised funds and organized a food relief operation. Scouts of China issued a COVID 19 guideline and shared it with other countries, they also volunteered to help pack medical masks. Scouts of Fiji focused on homeless people to help them understand the situation and to give them protective equipment. In Kenya, scouts provided families with resources for online school classes, and gave conferences to parents in order to assist their children's education. The Philippines gathered masks, shields, and raised money to help their communities. Scouts from Sri-Lanka distributed dry foods and vegetables for dozens of families facing difficulties from the pandemic. Many countries have changed their entire program activity set to virtual to avoid more infections, and have similar experiences in the development of projects in order to contribute to the resolution of the pandemic.

One of the most important part of the scouting method involves community engagement, this is where active learning takes place since scouting encourages youngsters not only to develop skills but to support their communities in a practical way. All this indoctrination is made using dialogism, in which scouts find personal meaning to specific words, ideas or even experiences as the ones mentioned above.

When scouts from all over the world realized that COVID 19 pandemic had exceeded the health sector capacity of Covid prevention and/or treatment, initiatives where taken without waiting instruction of scout leaders. Youth immediately searched for adult guide to identify ways to help persons in need. With the help of their families, they crafted face masks using their own funds, and donated them to hospitals and police stations. Scouts felt better because they were helping the cause and soon started to seek other ways to help the community, this is where esthetics comes in place since scouts are experiencing that they are doing something beautiful that makes them feel proud. Scouts were able to see the results of their work, so they even became more engaged to help the community.

As months passed by, scouting activities have changed, scouts continued to develop prevention materials making face masks and helping with sanitization of public places, thermal screening, and stress management in underprivileged shelter homes. All this process is being documented and it is being presented to the NSO. So participant scouts can get the international badge known as "Messengers of Peace" (MOP). This is where semiotics take place since all the persons who bear the MOP have contributed to the development of their own communities through a project. Scouts who earned the MOP badge attribute a special meaning to it, since it represents their own effort to help and participate in an active learning procedure in which they overcome all sorts of obstacles to fulfill their goal. These five elements combined, act directly into the youngster's development and learning objectives.

9. Conclusions

Active learning is one of the best ways to potentiate learning. Involvement creates interactions that enable youngsters to have a better understanding of different learning processes that they should go through. Non-formal education was designed to learn "in situ", and one of the most important cornerstones of it is "learn by doing", making non-formal education a foundation for active learning.

The program and SM of WOSM has proven for over 110 years to be one of the best places for active learning in the world. Millions of scouts work daily to ensure this, not only creating local interactions and regional activities but working with other scouts worldwide to develop joint projects that seek to answer their community needs.

This chapter presented how the world scout movement uses non-formal education and active learning to develop educational goals worldwide. It also explained the program, methodology, and core foundations of scouting. This gives a better understanding of how active learning is used in scouting, and the elements that the scouting movement developed over a century ago that helped build the largest youth community in the world.

The pandemic of COVID 19 changed the entire social and economic scenario. The scouting movement was not prepared to work entirely online. Scouting program was designed based on a face to face interaction, in this sense, adjustments had to be done worldwide to ensure the continuation of the movement. Despite this, online scouting is a reality and need to keep adjusting to youth's needs and interests. This also means that there is an opportunity area within adult training, because of the lack of abilities on information technologies and social networks. Even additional

educational strategies that do not rely on technology can be helpful, in order to avoid the issues of lack of resources such as computer equipment or internet access.

Finally, one of the biggest contributions of scouting to active learning has been to develop a methodology that involves playing and learning at the same time, in this way, youth has an enjoyable time while learning actively and helping others.

Acknowledgements

The Autonomous University of Chihuahua.
World Organization of the Scout Movement.
World Organization of the Scout Movement, Asia Pacific Region.
World Organization of the Scout Movement, Inter-American Region.

Conflict of interest

The authors declare no conflict of interest.

Appendices and nomenclature

NSO	National Scout Organization
MOP	Messengers of Peace
SM	Scout Method
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WOSM	World Organization of the Scout Movement

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Chapter 5

Activity-Based Online Learning: A Response to Dyslexia and COVID

Charles Potter

Abstract

Dr. Charles Potter's Reading Fluency Programme implements individual learning programmes focusing on children's learning needs. The methods and materials can be used in the treatment of dyslexia, as well as for working with children with reading, writing, and spelling difficulties or difficulties with rate of work at school. The programmes are activity-based, and are introduced through online sessions related to the child's individual learning needs as identified through initial assessment and ongoing evaluation. Based on assessment, an individual programme is developed for the child, focusing on areas of need. The programme then uses electronic books, activity books and materials for treatment of phonological and phonemic difficulties, phonic difficulties, as well as linked problems with reading, writing, spelling, reading comprehension and working memory development. This chapter provides theoretical background on the neurolinguistic basis of the programme's methods and materials, which have been developed internationally and implemented pre COVID with both first and second language speakers of English. It also provides information on how the materials have been implemented post COVID using activity-based online learning formats, and the results of children based on pre and post assessments.

Keywords: dyslexia, reading, writing, spelling, working memory, electronic materials, activity-based online learning

1. Introduction

Dr. Charles Potter's Reading Programme has been previously described in a number of publications. These have documented the theory behind the development of the programme's methods and materials [1], as well as how the methods and materials have been applied in working with children with learning difficulties [2–4].

The programme is both research and evidence-based, and attempts to address reading, writing and spelling problems through activity-based learning targeting the child's specific functional areas of difficulty identified in assessment. As the programme's materials are electronic, they can be sent out by email, and there is a network of parents, teachers and therapists using the programme both locally in the SADEC region as well as internationally in the United Kingdom and in Kenya. The results have been promising, based on effective use of the materials and methods both in individual programmes involving direct physical contact as well as online.

This chapter describes how the approach to activity-based learning has been developed and implemented both prior to COVID as well as post-COVID. Pre-COVID, an activity-based approach was used based on contact sessions with supporting activities provided for implementation at home. During lockdown the activities were adapted for online work. What has been developed post-COVID is an activity-based approach to teaching reading, writing and spelling which can be implemented either through contact sessions or online. As all materials are electronic, this means that the programme can be effective in any locality in the world where parents, teachers, therapists and schools speak English, and have access to electricity and the internet.

2. Activity-based learning

Our approach to activity-based learning is based on the neurolinguistic theories of the Russian neuropsychologist Alexander Luria [5–7], who suggested that human mental processes are complex functional systems that involve groups of brain areas working in concert. Each system evolves as the child develops, and makes a unique contribution to the organisation of the central processing conducted by the brain [8].

Based on the theories of Leontiev [9–11] and of Vygotsky [12–14], Luria [15] suggested that the development of higher mental functions takes place in stages. The process of learning is activity-based for the reason that the consolidation process is activity-based. It is based on increasing automaticity, in which a complex cycle of unconnected acts become a highly automatized skill. This principle applies to many different mental functions, including the neurolinguistic functioning involved in development of the ability to read fluently, to write fluently and to spell fluently [16].

3. Automaticity in reading

In terms of Luria's conceptualisation of the development of higher mental processes, the development of automaticity in reading is essential for its use in the hierarchical processing of information by the working brain. Following Luria [17], automaticity would be developed in reading when there has been sufficient practice to enable this complex functional act to become fluent enough to form the basis for higher mental processing.

Heckelman [18–19] was the first to record the use of paired reading as a method for increasing reading fluency, while LaBerge and Samuels [20] were the first researchers to focus on automaticity as a function of how reading fluency develops. Samuels [21] suggested that automaticity in reading could be trained through procedures involving repeated reading. As Samuels commented:

> *"It is important to point out that repeated reading is not a method for teaching all reading skills. Rather, it is intended as a supplement in a developmental reading program. While the method is particularly suitable for students with special learning problems, it is useful for normal children as well." [22].*

The association between reading fluency and automaticity has then recurred in subsequent literature, with repeated reading being identified as effective when implemented in a variety of ways, and in a variety of different contexts. Repeated reading has been used effectively as a method for developing reading by

teachers [23–28], parents [29, 30], as well as peer tutors [31–35]. The evidence from these various types of implementation has been positive, effects have often been rapidly obtained, and variations in implementation procedures have produced similar positive effects (e.g. [36–45]).

Overall, automaticity has been associated with the development of both oral reading ability as well as comprehension [46–48]. Based on review and meta-analysis of the literature, the National Reading Panel [49] concluded that there was:

> *"a persuasive case that repeated reading and other procedures that have students reading passages orally multiple times while receiving guidance or feedback from peers, parents, or teachers are effective in improving a variety of reading skills. It is also clear that these procedures are not particularly difficult to use; nor do they require lots of special equipment or materials, although it is uncertain how widely used they are at this time. These procedures help improve students' reading ability, at least through grade 5, and they help improve the reading of students with learning problems much later than this." [50].*

4. Activity-based methods for developing fluency in reading

Wolf and Katzir-Cohen [51] have argued that as there are a number of levels of subskills and components in reading fluency instruction, there is a need for curricular strategies in dealing with fluency-based issues. They suggest that increased exploration of the subskills and components of, and issues surrounding, fluency and comprehension will contribute to understanding of both reading development as well as dyslexia subtypes.

The literature also indicates that dyslexia is best conceptualised as a spectrum which is associated with many different aspects as well as deficiencies in a number of areas of functioning [52–55]. What this implies is that reading, writing and spelling difficulties are likely to be complex, and require treatment directed at a number of variables.

For this reason a multivariate approach to fluency-based work is used in our programme. Variables affecting the child's functioning are identified through assessment. Treatment then focuses on these variables, focusing in particular on effecting change in reading fluency, writing and spelling fluency, as well as in the cognitive and metacognitive skills involved in rapid naming and sequential working memory development. Based on the variables indicated in assessment, the methods used in our programmes are individualised and activity-based. These are introduced through either contact or online sessions, or a combination of these.

Both identification of needs and implementation are thus evidence-based. Based on assessment, an individual programme is developed which targets the child's individual learning needs through focus on particular variables and their neurolinguistic underpinnings. Implementation then takes place using electronic books, activity books and materials using research and evidence-based methods. Effectiveness of treatment is monitored through ongoing evaluation.

5. The 3 x 3 oral impress method

The methods used in our programme for developing reading fluency involve repetitive paired reading of sentences at foundation level, and repetitive paired reading of paragraphs once the child is able to read at a basic level. We have used an activity-based method called the 3 x 3 Oral Impress Method effectively [56, 57].

This is designed to stimulate the visual word form area in the brain identified by Dehaene [58, 59] through repetitive exposure to large-print phonically-based material, using repetitive reading and repetition of words in text to develop increased rate of reading based on increased accuracy of phonological decoding as well as lexical familiarity [60–63].

The appropriate starting point in the programme is identified through assessment. A sequence of graded written material is then used based on phonograms and rimes which are embedded in the text of a series of electronic reading fluency books, which can be either sent out by email or purchased online. Each word acts as a stimulus as the brain develops the ability to process increasingly complex phonically based reading material.

Repetitive reading of sentences is conducted at foundation level until the child's reading skills develop to the level where basic level reading material can be read by the child and a reading partner. Repetitive reading of paragraphs is then introduced, with the reading of each paragraph being repeated three times. After the first three paragraphs have been read repetitively in this way, the next three

Paragraph One	Child reads	Parent and Child read together	Parent reads
Paragraph Two	Parent reads	Child reads	Parent and Child read together
Paragraph Three	Parent and Child read together	Parent reads	Child reads

Table 1.
The 3 x 3 Oral Impress Method.

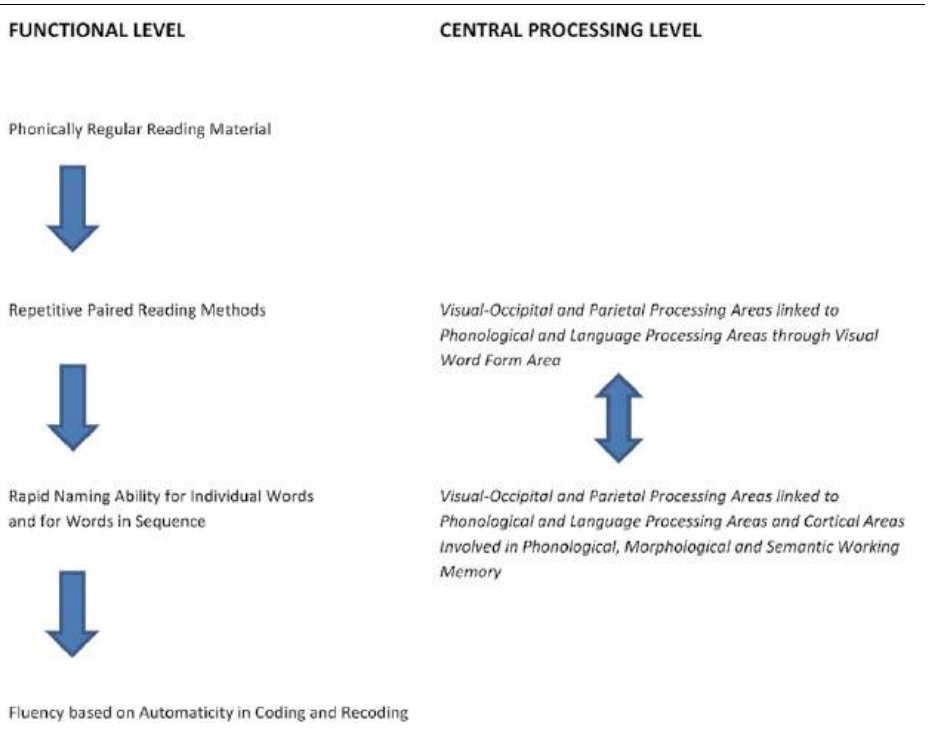

Table 2.
Model for Reading Fluency Development.

paragraphs in the story are then read repetitively, with additional repetition taking place through repeated use of words in the text of the books, on the model presented in **Table 1** above.

What this means is that the child is exposed to carefully structured repetitive use of graded reading material using large-print books in which the words and sequences of words are systematically chosen and graded [64]. The amount of text in paragraphs is also limited [65]. The books are printed using on one side of the page only. This is done for visual attentional reasons [66, 67], as well as to reduce clutter [68].

The material is then read repetitively on the model summarised in **Table 2** above, with each paragraph being read three times. In the process, the child is given the active support of a reading partner as well as the repetition of graded phonically-based words and sequences of words necessary to learn to read, and then to read fluently. As with the paired reading methods described by others [69–72], the 3 x 3 Oral Impress Method method is designed to provide an avenue through which a skilled reader (eg a parent, therapist, teacher, tutor or a reading partner) can work with a child, with both the visual cueing and voice of the skilled reader, and the phonic basis of the large-print reading material, providing the associations necessary for reading to develop.

6. Similarities and differences to the paired reading methods used by others

Similar activity-based paired reading methods have been used by others with success. The 3 x 3 Oral Impress Method is similar to the methods developed by Heckelman [73, 74], in involving the child and his or her reading partner in activities involving oral reading. For this reason we follow Heckelman in using the term "impress" because paired reading is used, with the reading partner's voice being provided and heard by the child, while the child also reads out loud.

As Heckelman [75] has observed, the combining of an external voice and the child's voice provides continual active involvement in the reading process together with oral stimulation, as well as feedback on whether words are being read correctly. The child thus sees the word, hears the word and speaks the word. The child's reading partner guides the process of oral reading and repetition.

However, the 3 x 3 Oral Impress Method has the following differences to the paired reading methods used by others.

- It is applied by parents, teachers and therapists using large-print, phonically-based reading material designed and printed in a way which reduces crowding and clutter, which have been identified as factors potentially interfering with focus on the printed word [68].

- It is designed to enable visual tracking to be built into the reading process [76, 77].

- At pre-reading and foundation levels, the materials are designed to integrate reading, writing and spelling with the introduction and teaching of phonemic skills [78]. This is done through use of a structured language experience approach, in which words introduced in the materials are linked with additional vocabulary based on the child's own language [79].

- Following both Luria [80–82] and Dehaene and co-workers [83–85], repetitive reading of graded large-print phonic material is then used at basic and

intermediate levels in the programme to repeatedly stimulate the areas of the brain involved in the reading process.

- As research indicates that phonological awareness and rapid naming are discrete factors which both influence the development of reading ability [86, 87], rapid naming activities are used side by side with reading fluency, phonic analysis and short-term visual memory activities to increase the child's ability to process words of different alphabetic length rapidly and accurately [88–91].

- At all levels in the materials, variation of order of reading and repetition of paragraphs read is provided by the method, as well as the repetition of particular words within the materials. As the materials are phonically based, they can also be used for phonic analysis, to introduce skills relating to the spelling of individual words, as well as to develop working memory skills relating to the reading and spelling of words in sequence [92].

This means that our programme's fluency materials are normally used for a number of different purposes, as well as for different combinations of reading, writing and spelling activities. The level and sequence of activities is adjusted to suit the learning needs of particular children. With beginning readers, the phonic complexity and the size of unit read can be decreased and the amount of repetition increased. As fluency develops, the size of unit read and its phonic complexity can also be increased and the amount of repetition reduced. Rapid naming of numbers and words is also introduced as an integral part of the programme with the aim of developing rate and accuracy of numerical, orthographic and lexical processing [93].

The neurolinguistic model for reading fluency development used in our programme links activity, function and underlying cortical processing and has been presented in **Table 2** above. It can be summarised as follows:

At the activity level, phonically-based large print materials are used for repetitive paired reading, with the aim of developing rapid and accurate naming of individual words, and words in sequence. At the central level, the repetitive paired reading methods would involve both forward and reverse processing from the visual and occipital areas of the cortex through the different functional sections of the visual word form area to the areas of the cortex involved in phonological and language processing [60, 94].

7. Automaticity in writing and spelling

Luria [95, 96] proposed that automaticity is necessary for any act (including reading, writing and spelling) to become fluent. Fluent acts then form the basis for higher level processing. Luria suggested that writing follows other mental processes in being a process which changes on a functional level, and that changes on a functional level reflect greater functional integration in the brain.

The methods used in the initial stages of our programme follow Luria in focusing on memorisation of the graphic form of each letter. We also follow Luria in developing the sounds associated with each letter as the child is exposed to the graphic form of each letter. We thus integrate the introduction of reading, writing and spelling with the introduction of phonics, with the associations developed through a sequence of activities.

The aim is that with practice, the performance on each individual element becomes altered as writing develops into what Luria has called a single "kinetic melody", in which the structures underpinning the process of writing individual

letters become automaticised and integrated. Similar changes also take place in other higher mental processes to which the writing process is linked [97].

What this means is that it is not only the functional structure of the processes of writing and spelling which change as automaticity develops, but also their cerebral organisation, as the activities of writing and spelling start to depend on different systems of concertedly working zones [98]. Following Vygotsky [99], this process of organisation is based on new, intermediate structures of mental processes and new interfunctional relationships which enable the performance of increasingly complex tasks by new methods [100].

Following Luria, the development and assessment of writing and spelling are linked to the development and assessment of reading ability. In our programme, automaticity is thus conceptualised as central to the development of writing and spelling, as a process which enable their development into a single "kinetic melody" [101] capable of supporting the use of reading, writing and spelling in higher mental activity.

8. The structured language experience approach

For the reasons outlined in the previous section, the methods and materials used in our programme are designed to integrate the teaching of writing and spelling with the teaching of reading. The child develops writing based on use of an activity book which is phonically-based, and which introduces the associations between sounds and letters through rhyming word families.

At the foundation level, reading comprehension is taught from the outset. This is done through a process of instruction which is activity-based, using an approach called "The Structured Language Experience Approach", which is a phonically-based teaching method in which reading, writing, and spelling are integrated with the processes of drawing and illustration [102].

The materials used at foundation level in the programme consist of a series of activity books and reading books, with a set of key words accompanying each reading book. The sequence of words in the activity book is then used to teach sound-letter associations, which are introduced through sets of rhyming words. These are used as the basis for developing sentences for purposes of reading, writing, spelling, language development and comprehension.

To avoid clutter, each page in the activity book consists of a limited number of rhyming words based on short vowel sounds, which are printed on the right hand page. The left hand page is left blank for writing and drawing. The words are then introduced as follows:

- The child first reads the rhyming words and illustrates each word with a picture for comprehension purposes.

- A short sentence is then made with each word on the blank page opposite. Each sentence uses the child's own language, as well as other words based on short vowel sounds.

- The sentences are read, and then copied by the child into his or her writing book, read again and then illustrated.

Once this has been done, the words and sentences can be typed on the laptop and illustrated with clipart. The child is assisted in this process, and the words and sentences are then printed out on plain paper to form the child's own language experience reading book.

At foundation level in the programme, the aim of the structured language experience approach is thus to extend the sets of rhyming words in the activity book through a sequence of activities based on the child's own language. This sequence of linked activities enables the rhyming words to be used in sentences which can then be copied, written, read and illustrated. Being based on the child's own language, it is then a small step for the child to be able to read the words in the sentences.

The sentences made in this way are then typed and then printed out as a language experience books. The child is also encouraged to dictate his or her own stories based on his own words and sentences, thus extending the breadth of his or her reading skills.

9. Phonological referencing

At both foundation and higher levels in the programme, the activities for developing automaticity in reading, writing and spelling are based on integrating reading, writing and spelling, and follow Frith [103] and Berninger et al. [104] in stressing the need to link the evolving processes of reading and writing. They are also based on use of structured phonics, following Ehri [105, 106], who has suggested that the beginning reader/speller progresses through phases of proficiency related to his or her developing alphabetic and phonological knowledge.

The child's spelling of the rhyming words introduced in the activity books is also tested. This follows Ehri [107, 108] who suggests that orthographic learning comes about through experience with printed language, in the process of which longer and longer letter strings become stored in memory. Children in the final "consolidated alphabetic phase" are able to read fluently as well as spell accurately, by relying upon these stored orthographic representations.

Our methods for teaching spelling in the initial stages thus follow the phonologically and phonically-based stages in spelling described by Moats [109, 110]. Focus is placed on teaching through synthetic phonic approaches incorporating teaching children to isolate sounds and blend sounds into words, as well as how to create families of rhyming words based on similar phonological and phonemic elements. In addition, as the child establishes reading fluency through our foundation level and then our basic readers, our methods use activity-based learning to build the variety of phonic associations necessary to read, write and spell as follows:

- The child is taught to map the associations between the sequences of letters used in words and the sequences of sounds used when words are spoken orally through use of phonogram and rime cards, as well as through a process we call "phonological referencing".

- This is based on the principle that "what we say is what we write." Phonic associations are taught through graded rhyming word activities involving reading, writing and use of working memory in spelling, as well as through activities in which the hand is placed under the chin to to increase the ease by which the vowel sounds in words can be identified, and the process of mapping letters to sounds and sounds to letters.

- This enables focus on the vowel sounds in words (which are spoken when the mouth opens) and the consonant sounds (which are made when the mouth closes). These associations are then used to identify the vowel letters and the consonant letters used in written words, and then to link these back to the sounds made when the word is spoken orally.

- Reverse mapping between the sequence of sounds in the word and the letters used in writing the word then takes place. Once the vowel sound in the word has been identified, the letters used to represent the vowel sound are then colour coded. In the process, short vowel sounds are identified as normally being made by one letter working by itself, while long vowel sounds are identified as normally being made by two letters working together.

- As part of the phonological referencing and colour coding process, the child is taught a phonic analysis system called "The Seven Vowel Phonic Analysis System" [111] in which the child learns that a, e, i, o and u are the letters normally used to represent the vowel sounds in words, but that y and w can also be used to represent the represent the vowel sounds in positions at or near the end of written words in English.

The Seven Vowel Phonic Analysis System is then worked with and applied through activities in which the letters used to represent the vowels are identified through phonological referencing. Through activity-based learning the child learns that there needs to be a vowel in every word, and that the letters a, e, i, o and u are used to represent the vowels in all positions in words, and that the use of y and w as vowels at the end of words is both logical and consistent, applying to nearly all words in English. The system thus aims to make written English as transparent as Welsh, in which the use of the seven vowels a, e, i, o, and u, as well as y and w, also applies [112, 113].

10. Developing phonic associations as the basis for learning to spell

At foundation level and at reading ages up to 8 years of age, our programme would follow Moats [114, 115] in targeting phonic associations in a hierarchy in which words based on short vowel sounds would be introduced first, followed by words in which more than one letter is used to represent the vowel sounds. A set of phonic inventories is used both during initial assessment as well as during programme implementation to establish the phonic associations the child knows and does not know.

Particular phonic associations are targeted using phonogram and rime cards, as well as materials based on sets of rhyming words supported by sentences which use the rhyming words in context. Phonological referencing is then introduced on this phonically based material, focusing on how the sounds made when speaking a word orally can be mapped directly to the letters used in writing the word. Once the child has been exposed to phonological referencing using written material based on families of rhyming words, the Seven Vowel Phonic Analysis System is introduced, working with the phonically-based material in our reading fluency books.

The process of developing writing and spelling fluency is then based on a sequence of phonic analysis activities which are undertaken repetitively. The aim is to use accuracy in use of sequential working memory for words to provide the building blocks for developing fluency and automaticity in writing and spelling. The neurolinguistic model for writing and spelling fluency development links activity, function and underlying cortical processing and is summarised in **Table 3**.

The model is applied repetitively and iteratively through activity-based methods, using forward and reverse processing between oral and written language to demonstrate that "what we say is what we write." The activities involved in repetitive phonological referencing are then used as the basis for developing rapid and accurate use of working memory for individual words, and words in sequence.

FUNCTIONAL LEVEL	CENTRAL PROCESSING LEVEL
Copying of Phonically Regular Material	*Visual-Occipital and Parietal Processing Areas linked to Phonological and Language Processing Areas Involved in Reading and Writing of Individual Words and Words in Sequence*
Mapping Written Text to Sounds of Oral Language through Repetitive Phonological Referencing	*Visual-Occipital and Parietal Processing Areas linked to Phonological and Language Processing Areas Involved in Phonemic Analysis of Individual Words and Words in Sequence*
Use of Working Memory in Learning Letter Combinations Used in Words and Sequences of Words in Written Text	*Visual-Occipital and Parietal Processing Areas linked to Phonological and Language Processing Areas and Additional Cortical Areas Involved in Phonological, Morphological and Orthographic Memory for Individual Words and Words in Sequence*
Fluency based on Automaticity in Coding and Recoding	

Table 3.
Model for Writing and Spelling Fluency Development.

11. The seven vowel phonic analysis system

It will be clear from the previous section that the Seven Vowel Phonic Analysis System is an activity-based procedure for teaching how to map the combinations of letters used in writing words to the sounds made when those words are spoken orally. It focuses in particular on developing skills in word attack as well as in spelling, through focusing on the letters and letter combinations used to represent the vowel sounds in words.

Based on Oaks [116], the Seven Vowel Phonic Analysis System focuses on the vowel situation in words. Following Luria [117–119] it teaches the associations between sounds and letters repetitively, working with paragraphs drawn from the phonically-based material in our reading fluency books. As the written language in these is carefully structured and graded, it is a small step to using the material in the books for activities involving phonological referencing.

The Seven Vowel Phonic Analysis System is designed to make written English more transparent as compared to transparent orthographies such as Italian or Afrikaans or Welsh. This increases the ease with which the child can apply the universal phonic principle to the task involved in learning to read, write and spell in English [120–122]. Difficulties in developing linguistic awareness and the universal phonic principle are thus assisted, as suggested by McCutchen [123], by introducing the metacognitive strategies involved in using the Seven Vowel Phonic Analysis System, with the aim of increasing the consistency with which the letters used to

Work with phonic weaknesses →	Target specific types of phonic errors made by child
← Teach phonic analysis skills →	Work with seven letters to increase vowel transparency
← Train working memory for words →	Combine phonic analysis and mental imagery in revisualisation
← Train sequential memory for words →	Work with sequential revisualisation and dictation
← Address spelling errors →	Work with phonograms and rimes

Table 4.
Model for Development of Sequential Working Memory for Words.

represent the vowel sounds in the English language can be mapped back to the sounds made when words are spoken orally [124].

This is done through an activity-based method based on five steps:

Step One: A descriptive paragraph from the child's reading fluency book is copied into the child's writing book.

Step Two: The letters representing the vowels in each word are identified by placing the hand under the chin and then underlined in colour.

Step Three: Target words (defined as words in which more than one letter is used to represent the vowel sounds) are then analysed using phonological referencing.

Step Four: The target words are then written, occluded by being covered with the non-dominant hand, and then written again from memory.

Step Five: The sequence of words in the sentences in the paragraph is revisualised and then tested in sequence through dictation.

This five step procedure is then used repetitively, with the aim of providing the phonic analysis and sequential working memory skills necessary for the development of writing and spelling fluency. This is done through a sequence of activities designed to develop the ability to use phonologically-based, phonically-based and visually-based sequential working memory skills.

The sequence of activities is called "targeted revisualisation". It is called "targeted" as the learning process focuses on target words (words in which more than one letter is used to represent the vowel sounds), which are then analysed using the Seven Vowel Phonic Analysis System and then learned using computer-based visualisation techniques. The process of targeted revisualisation involves the child in revisualising individual words, by first speaking the sequence of letters seen in the mind while visualising the words, and then using sequential working memory to write both individual words and sequences of words from memory.

How to do this has been presented in **Table 4** above, and is described in the next section.

12. The targeted analysis, revisualisation and sequential spelling programme (TARSP)

The Targeted Analysis, Revisualisation and Sequential Spelling Programme [125] is based on indications from the literature that even in pictographic written language systems like Chinese, children learn to read using phonic strategies

[126, 127]. In introducing the Targeted Analysis, Revisualisation and Sequential Spelling Programme, the child is taught through combining phonic analysis and revisualisation in activities designed to develop sequential working memory for words.

This is done as follows:

Step One: The child uses the Seven Vowel Phonic Analysis System to identify the target words (words in which more than one letter is used to represent vowel sound) from a graded written paragraph, and lists these in his or her writing book.

Step Two: The child types the target words on the laptop and uses phonological referencing to identify and then colour code the letters used to represent the vowel sounds in each target word.

Step Three: The child is taught how to revisualise the target words using a combination of phonic analysis and mental imagery.

Step Four: The accuracy with which the child remembers the target words is then tested by writing the individual words from memory.

Step Five: The child is taught how to use sequential working memory to recall the form and structure of the words in the paragraph in sequence. This is done by teaching the child how to revisualise and recall the sequences of letters used both in the individual words, as well as how to revisualise and recall the sequences of words used in sentences and paragraphs.

Step Six: Errors made by the child in writing the words and sequences of words from memory are identified. Phonic associations are taught using phonograms and rimes. The error words are then phonologically referenced, learned through occlusion and used in written sentences.

The process of targeted revisualisation thus involves work in four areas (phonic analysis based on phonological referencing, revisualisation, developing sequential working memory for words, and systematic phonic instruction targeting the spelling errors made by the child). These are linked through a sequence of activities, each of which plays an integral part in developing accuracy in use of sequential working memory, as described in the section following.

13. Developing sequential working memory for words

The aim of the Targeted Analysis, Revisualisation and Sequential Spelling Programme is to develop sequential memory for written words, based on the evidence of a common linguistic awareness manifesting in phonological, orthographic, and morphological awareness as suggested by Berninger et al. [128, 129]. It applies phonic principles in analysing and recalling words in sequence, based on the evidence of a universal phonic principle manifesting across different orthographies as suggested by Perfetti, Zhang and Berent [130] (1992). Following McCutchen [131], the Targeted Analysis Revisualisation and Sequential Spelling Programme aims develop linguistic awareness through the metacognitive strategies involved in phonological referencing, as the basis for developing sequential working memory for words.

The process of targeted revisualisation is based on a sequence of visually cued phonic analysis and phonological referencing activities which are undertaken repetitively. The aim is to develop accuracy in use of sequential working memory for words to provide the building blocks for developing fluency and automaticity in writing and spelling. This is done through repetitive activities undertaken in four stages, as follows (**Table 5**).

Level of Mediation	Focuses of Phonic Analysis	Focuses of Mental Imagery and Revisualisation	Focuses of Use of Sequential Working Memory
Stage One: Focus on Words based on Short Vowel Sounds	Introduce concept that vowels are used in all spoken and written words. Identify and mediate short vowel sounds a, e, i, o, and u.	Construct, deconstruct, mentally image and revisualise words and rhyming word families containing short vowel sounds.	Use working memory in writing rhyming words based on short vowel sounds in sequence.
Stage Two: Focus on Words based on Long Vowel Sounds	Identify and mediate long vowel sounds involving use of digraphs involving a, e, i, o, and u. Introduce the letters y and w as vowels in positions at or near the end of words.	Construct, deconstruct, mentally image and revisualise words and rhyming word families containing long vowel sounds, including use of the letters y and w as vowels in positions at or near the end of words.	Use working memory in writing sequences of words containing both long and short vowel sounds, including use of the letters y and w as vowels in positions at or near the end of words.
Stage Three: Focus on Sequentialisation of Words in Sentences	Identify letters used as vowels in words used in sequence in sentences.	Identify, phonically analyse, mentally image and revisualise single syllable and polysyllabic words in sequence in sentences.	Use working memory in writing single syllable and polysyllabic words in sequence in sentences and sequences of sentences..
Stage Four: Focus on Sequentialisation of Words and Sentences in Paragraphs	Identify letters used as vowels in words used in sequence in sentences, and in sentences used in sequence in paragraphs.	Identify, phonically analyse, mentally image and revisualise single syllable and polysyllabic words in sequence in paragraphs.	Use working memory in writing sentences in sequence in paragraphs of increasing length and phonic complexity.

Table 5.
Summary of Stages and Focuses of Mediation in the Targeted Analysis, Revisualisation and Sequential Spelling Programme.

On a phonological and phonic level, the model is based on the coding and recoding of phonic associations through activities in which the child writes, types and colour codes the vowels in words, by underlining the letters used to represent the vowel sounds in colour as well as using the colour coding feature in a word processing programme. On a visual level, the model is designed to make the letters used to represent the vowel sounds in words stand out in colour.

As this occurs, both the phonic associations and visual contrasts used to identify the letters representing the vowel sounds in words are used to develop working memory for words as well as sequential working memory. Fluency in writing and spelling is then based on increasing automaticity in recalling the sequences of letters used in individual words, the sequences of words used in sentences, and the sequences of sentences used in paragraphs. Spelling errors made by the child are retaught using methods based on phonological referencing, occlusion and use of an electronic tachistoscope.

14. Implementation and results pre COVID

Pre COVID, our methods and materials for developing automaticity in reading, writing and spelling were implemented over a number of years through contact

sessions in my practice, as well as by a network of other therapists, teachers and parents using our methods and materials. From first interventions using large-print phonically based materials in the 1990's to the date of lockdown in our country in March 2020, positive results were obtained which have been presented in a number of previous publications on the programme [132–135]. These can be accessed online by clicking on the links in these references at the end of this chapter.

Based on aggregation of the individual case study analyses of results obtained through use of the programme's materials and methods, longitudinal trends in the data indicated that the following variables influenced successful implementation of the programme over an eight year period:

- Consistent and regular exposure to phonological and phonic instruction to provide a foundation of basic skills on which the fluency interventions in the programme can be built;

- Consistent implementation of methods designed to improve both reading fluency and writing and spelling fluency to produce the greatest likelihood of positive effects; and

- Consistent support from parents in programme implementation to produce the greatest likelihood of positive effects.

Where the above variables have applied, results post-COVID have also been consistently good, based on contact implementation, online implementation as well as implementation strategies involving combinations of online and contact implementation. These are described in the section following.

15. Strategies for programme implementation post COVID

COVID lockdown presented a number of challenges, but also provided a number of opportunities. Many of the challenges stemmed from my own decision to discontinue contact sessions in my practice until such time as a vaccine became available. This led to a variety of additional strategies for implementing our materials and methods, using formats involving online sessions supported by additional home-based sessions for children.

Examples of the types of format used are presented in **Tables 6** and 7 below.

The formats enabled parents and tutors to work with children using a variety of different types of activities linked to materials which were delivered by email over the lockdown period. This then provided opportunities for extending the range of online services provided by my practice as well as the extent of materials, methods and assessment tools used for online work.

As the schools also moved to online work, each child's programme was individually designed to develop the basic skills necessary to be able to complete the assignments being set by the child's classroom teacher. Both the programme provided by the child's school and our own programme activities would then be supported by either the child's parent or a tutor.

It thus became possible to provide an activity-based individual programme for the child drawing on the following types of materials from my practice's data-base:

a. Materials and methods for work with phonic skills and phonic analysis.

b. Materials and methods for reading fluency development.

	First activity	Second activity
Day One	Test-based Language Programme Level One Test 2 Creative writing activity Use key words to write a story, then draw the picture. Then use Google dictate to tell the story and get the spelling right.	Language analysis Circle nouns 2
Day Two	Use Level Two Phonogram and Rime Cards to build the following rhyming word family The ou digraph The ou Family out shout gout trout found bound mound loud cloud proud house mouse louse grouse Write these words in your writing book. Then underline the vowels in each word in colour. Test the spelling of the words. Illustrate each word for comprehension purposes.	Now write the following sentences in your writing book. I am very proud of you. She found the ring in the sand. Can you see out of the car? They want to go into the house. There was a black cloud in the sky. This band is quite loud. There is a white mouse in her room. He will shout my name. Underline the vowels in each word in each sentence in colour. Test the spelling of the words in each sentence in sequence through dictation. Then iIllustrate each sentence for comprehension purposes.
Day Three	Maths activity: Test-based Maths System Level One Test 2 Input output rules Finding number patterns	Maths extension activity: Level 1: input output charts a Level1: find number patterns a Rapid naming activity Level 1: adding objects b Level 1: counting patterns -b
Day Four	Test-based Language Programme Level One Test 2 Written language activities	Phonic Analysis Level 2: phonics long vowels b

Add:
Daily repetitive paired reading on basic evel reading fluency book.
Daily work in Level One phonic workbook or in Level Six foundation level activity book.
Daily maths activities on maths website.

Table 6.
Activity-based Learning Format Designed for Work with an 8 year old child. Learning Cycle Eleven implemented on July 18th 2020

c. Materials for language skills development.

d. Structured language experience activities.

e. Materials for reading comprehension development.

f. Cloze activities.

g. Activities for identifying main ideas and summarising skills.

h. Reading activities based on use of the internet.

i. Materials and activities for descriptive and creative writing development.

j. Materials and methods for word analysis and working memory development.

k. Materials and methods for sequential working memory development.

l. Writing and spelling fluency activities involving phonic analysis and revisualisation.

m. Materials and methods for developing rapid naming and rapid processing abilities.

n. Listening skill and auditory processing activities based on use of audible books.

o. Test-based language and maths activities.

p. Problem-solving techniques and activities.

Post COVID, feedback on how the child has coped with each type of activity is provided by photographs sent by email or WhatsApp, enabling the next format in the child's programme to be evidence-based, linked to ongoing evaluation of learning needs. Assessment is then built into programme implementation at regular intervals. The model used for implementation is action research based, and is presented in **Table 8** on the next page.

As the practice's data-base is extensive, the planning and implementation model summarised in **Table 8** implies that each child's programme can be multivariate, addressing a number of different learning needs through use of a variety of graded activities. The programme is then implemented using online sessions supported by learning materials provided by email. The aim is that programme implementation can take place with support from parents or tutors, working with a variety of electronic materials made accessible online via links to websites, or delivered by email. Methods used in the programme are documented in illustrated implementer manuals, and are demonstrated working online, supported by cellphone and email contact.

	First activity	**Second activity**	**Third activity**
Day One	Test-based Language Programme Level One Test 8 Creative language activity Planning of creative writing combining divergent thinking and convergent thinking methods	Working memory activity using revisualisation methods: Identification of target words from graded revisualisation paragraph 21 followed by phonological referencing and colour coding of letters used to represent the vowel sounds in words in writing book and then on laptop. Syllabification and testing of target words	Sequential revisualisation of words and sentences in paragraph 21 Testing of sequential working memory for words in paragraph 21 through dictation
Day Two	Test-based Maths Programme Level Three Test 1 Comparison of numbers up to four digits Arrangement of numbers up to four digits according to size	Maths extension activity: level-3: compare numbers a level 3: order numbers a Rapid naming activity: Level 2: multiplication tables 2, 5 and 10 b Level 2: multiplication table 2 missing factor b	Language comprehension activity: Endangered species

	First activity	Second activity	Third activity
Day Three	Test-based Language Programme Level One Test 8 Written language activities	Descriptive writing A bicycle Use what, where, when, how and why questions to describe a bicycle. Use the internet to help you.	Maths/science comprehension activity Magnetic attraction
Day Four	Self-structured listening activity using Audible book, followed by review stating what the passage in the book is about, how it has been interpreted and enjoyed, and on the basis of this evidence whether the book is a good one with a message that speaks successfully to the reader.	Natural science comprehension: Atmospheric layers.	Error analysis: Correction of spelling errors made in summary – Learn error words using occlusion and use error words in sentences. Then work with rapid naming of error words using tachistoscope.

Add:
Daily repetitive paired reading on intermediate level reading fluency book.
6 word a day long term memory spelling programme (6 words a day times three days, learn and test the fourth day, learn any errors using occlusion and use error words in sentences). Use tachistoscope for rapid naming and writing based on use of short-term visual memory.

Table 7.
Activity-based Learning Format Designed for Work with a 12 year old child: Learning Cycle Five implemented 29th April 2020

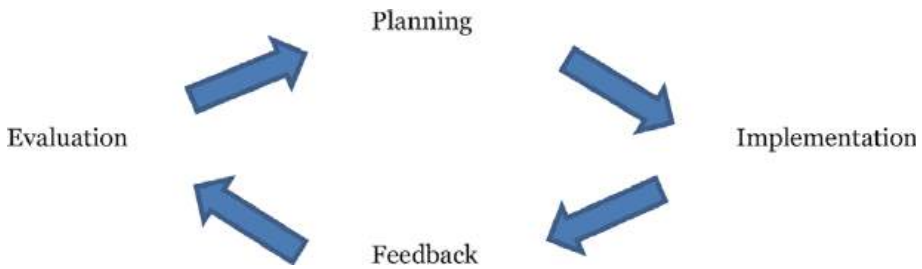

Table 8.
Action Research Cycle for Planning and Implementation of Activity-based Online Programmes.

16. Changes in assessment and training post COVID

COVID has also presented challenges and opportunities in both assessment and training in programme use. Pre COVID, assessment was undertaken through contact sessions, through a number of tests administered across the table. Programme implementation then took place working with therapists, teachers, tutors and parents who were trained in programme implementation through a mediated training programme.

Post COVID, the programme has developed assessment strategies involving combinations of contact and online work. Contact testing is conducted both locally and internationally, working in association with other therapists located in areas close to where children live. This is then supplemented by online testing, with the aim of developing an individual programme relevant to the child learning needs, at a level of language, reading, writing and spelling appropriate to the child's basic skills, and varied in terms of the child's individual needs.

Implementation then takes place through online sessions supported by learning formats based on materials and methods drawn from the electronic data base, with each activity focused on the child's learning needs. Training is provided to programme users as an integral part of the process. Manuals are provided to assist parents, teachers, therapists and tutors in implementing the reading, writing, spelling and working memory activities which form the basis of each child's programme. Additional support is also provided to programme users through training materials, as well as through sessions conducted online with the therapists, teachers and parents who work in association with my practice.

A number of parents, therapists and teachers are currently working with the practice's methods and materials, both in the SADEC countries as well as in the UK and East Africa. What has developed in response to COVID are combinations of contact and online assessment and training. With increased use of online technology, it has been possible to plan sessions and work online with others using the programme's methods and materials, and in the process to demonstrate which activities work best, how to implement activity-based learning using the programme's methods and materials, and exactly what to do step by step. This has led to forms of shared planning and implementation, supported by electronic materials and manuals.

These are exciting developments in which there are many possibilities for work in different geographical areas of our own country, which is culturally, linguistically and socio-economically diverse, but which uses English as the basis for schooling, commerce and the market-place. It has also led to both interest and implementation possibilities in other countries in which English is spoken and used as the basis for work in schools, as well as more broadly in society.

17. Summary and evaluation

The reading, writing and spelling fluency programmes described in this chapter are activity-based, and are introduced through online sessions related to the child's individual learning needs as identified through initial assessment and ongoing evaluation. Based on evidence provided by testing, an individual programme is developed for the child based on areas of need. Electronic books, activity books and activity-based materials are then used to develop automaticity in reading, and automaticity in writing and spelling, as well as to focus on linked difficulties in phonological and phonemic development, rapid naming and working memory development.

The methods and materials described in this chapter can be used as a response to dyslexia as well as for work with children whose skills in reading, writing and spelling are not well developed. Reading fluency is initially targeted, together with the development of phonic associations based on use of phonogram and rime cards as well as rhyming word families. Once observable differences in reading fluency are noted, reading comprehension activities are introduced together with visually cued phonic analysis based on phonological referencing methods, which are used as the basis for developing writing and spelling fluency.

Following Jorm and Share [136–140], the phonological referencing methods used in a child's programme are based on the teaching of skills for phonological recoding (print-to-sound translation, as well as translation of sound back to print). Phonic analysis and revisualisation are then used in combination to develop the detailed orthographic representations necessary for fast, efficient visual word recognition, as well as the detailed orthographic representations necessary to spell both individual words and words in sequence.

The methods used in our fluency-based programmes are thus multivariate, based on use of a combination of repetitive paired reading, repetitive phonological referencing, as well as the training of rapid naming and sequential working memory skills. The evidence from aggregated case studies of children who have worked with a combination of the methods described in this chapter indicates that there are benefits in improvement in reading, spelling individual words and spelling words in sequence, with backwash effects occurring across these areas. Case contrasts indicate lessened effects from programme implementation where there has been systematic variation in either the implementation of repetitive paired reading or repetitive phonological referencing using the methods described in this chapter, and in previous chapters on the programme [141–144].

Post COVID, both contact and online implementation have been undertaken in which materials from the practice's data-base are used in interactive sessions with children, with supporting manuals and training materials delivered to users by email. Each child's programme is then supported with formats designed to provide an activity-based learning programme focused on the child's learning needs. Training can also be provided to users interactively and step by step, with methods demonstrated either through contact or online, supported by implementation material, training material and illustrated manuals.

This hybrid assessment, training and implementation model has evolved as a response to the needs for social distancing required by COVID. The interventions with each child can be flexible as well as multivariate, and can be provided both locally and internationally wherever the internet and email are available. Both results and user evaluations are positive, indicating that there are a number of possibilities for post COVID implementation of the programme with children with reading, writing and spelling difficulties, and as well as with therapists, teachers and parents working with dyslexic children in different geographic areas and different countries.

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Chapter 6

Artificial Intelligence in Education

Andrej Flogie and Boris Aberšek

Abstract

Information technology, through networking, knowledge-based systems and artificial intelligence, interactive multimedia, and other technologies, plays an increasingly important role, which will even increase in the future, in the way that education is taught and delivered to the student. For this reason, we decided to present some ideas for such learning-training environments in education in this chapter. Like many researchers in other countries, we are also developing a user-friendly general system, designed particularly for solving problems. It is based on experience-based intelligent tutoring systems, and intended primarily for executing better lessons and for students' self-learning. Like all powerful tools, experience-based AI design approaches must be applied carefully. Without a carefully designed experience and extensive testing, these systems could easily result in unwanted outcomes (such as negative training or increased phobia anxiety). Despite the promise of the early efforts, the best approaches to designing these experiences are still topics of research and debate. Any technology as powerful as AI provokes many general social and ethical questions in all of us. Does AI make killing by remote control too consequence-free? Do AI models systematize existing biases? What will AI do when it enters education? We will try to provide an answer to this question in the following chapter.

Keywords: artificial intelligence (AI), education, machine ethics, machine behavior, intelligent tutoring system

1. Introduction

> *"Natural science is knowledge about natural objects and phenomena. We ask whether there cannot also be 'artificial' science – knowledge about artificial objects and phenomena."*
>
> *Herbert Simon*

> *Teachers will not be replaced by technology, but teachers who do not use technology will be replaced by those who do.*
>
> *—Hari Krishna Arya*

For years, experts have warned against the unanticipated effects of general artificial intelligence (AI) on society [1, 2], predicting that by 2029 intelligent machines will be able to outsmart human beings. Stephen Hawking argues that *"once humans develop full AI; it will take off on its own and redesign itself at an ever-increasing rate"*. Elon Musk warns that AI may constitute a "fundamental risk to the existence of human civilization". If the problems of incorporating AI in manufacture and service

operations, i.e. using *smart machines*, are smaller, as the 'faults' can be recognized relatively quickly and they do not have a drastic effect on society, then the *incorporation of AI in society and especially in the educational process* is an extremely risky business that requires a thorough consideration. The consequences of mistakes in this endeavor could be catastrophic and long-term, as the results can be seen only after many years. The threat of AI and its potential evolving into a commonly named 'superintelligence' can be summarized with the following thought of Boston:

"/.../ I try to understand the challenge presented by the prospect of superintelligence, and how we might best respond. This is quite possibly the most important and most daunting challenge humanity has ever faced. And – whether we succeed or fail – it is probably the last challenge we will ever face." [3].

The scientific background of such ideas and questions is based on the findings that have materialized at the intersection of the fields of philosophy (ethics), artificial intelligence, and pedagogy (education). Our research will stem from the findings of authors such as Turing, Bostrom, Rahwan, Kurzweil and others. Also, this idea is based on the European AI Alliance, which the European Commission launched at the beginning of 2018. The main documents are "*Artificial Intelligence for Europe*[1] [4] and "*Coordinated Plan on Artificial Intelligence* [5]."

The increasingly faster hardware and the progressively optimized software in the realm of computers have, during the course of the past few years, stimulated and disturbed academic philosophy, which quickly began pointing out the ethical issues that might arise with the usage of artificial intelligence. Saying that such problems are a thing of the distant future is not something philosophers and researchers of AI would agree with. AI expert Nick Bostrom (University of Oxford) offers the following answer to the question of "When will human-level machine intelligence (HLMI) be attained?": "10% probability of HLMI by 2022, 50% probability by 2040, and 90% probability by 2075" [3].

1.1 Why must we be careful?

Let us start at the beginning of the story about the easy and the hard philosophical problem of incorporating AI. If the problems of incorporating AI in manufacture and service operations, i.e. using *smart machines*, are smaller (hence the name, easy problem), as the 'faults' can be recognized relatively quickly and they do not have a drastic effect on society, then the *incorporation of AI in society and especially in the educational process* (hence the name, hard problem) is an extremely risky business that requires thorough consideration. The consequences of mistakes in this endeavor could be catastrophic and long-term, as the results will be seen only after many years.

AI is ultimately only a computer program, a "simple" optimization algorithm. Such algorithms can contain different ethical constraints (law) in the source code. A well-known historical example in the form of such simple "robotic laws" dates as far back as 1950, when Isaac Asimov proposed the following:

1. A robot may not injure a human being, or, through inaction allow a human being to come to harm.

2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law [6].

[1] http://www.ijcai-18.org/wp-content/uploads/2018/07/1_20180717_IJCAI_ECAI_Cecile-Huet.pdf.

It is clear from these laws that the robot (intelligent machine), or, in today's terminology, AI, must protect humans and put the safety of human beings before its own existence. 50 years later, however, Mark W. Tilden wrote similar, but at the same time different laws[2]:

1. A robot must protect its existence at all costs.

2. A robot must obtain and maintain access to a power source.

3. A robot must continually search for better power sources.

Tilden's laws suggest that the primary role of the robot (AI) is first and foremost to protect itself from the outside world, including human beings. Because the AI of today learns primarily from the world wide web, where both types of laws can be found, an ethical dilemma could thus be created: *which of these two sets of laws should be considered as guidelines, or, in other words, what is the Categorical Imperative for AI according to Kant* [7]*?*

1.2 Machine ethics and/or machine behavior

Machine morality in intelligent systems, whether physical systems with a mind and body or just thinking algorithms somewhere in the cloud, is a recurring issue. Morals demonstrate the relationship of humanity to nature and society and are manifested as a sum of values (rules, norms, principles, categories, ideals, etc.), according to which we make decisions, what is good and what is bad, what is just and what is unjust, what is right and what is wrong, and in line with which we also behave. When it comes to the morality of smart machines, philosophers mostly focus on theoretical questions such as: *does AI have the status of a moral agent, is AI responsible for its actions, is AI a 'being' with a higher moral status*, etc. – rather than on such a specific and practical area as is the usage of AI in education, especially in the field of ensuring social competences and developing emotional intelligence [8, 9].

The ethical dilemma related to the understanding and interpretability of the behavior of AI agents, is one of the pivotal challenges of the next decade of AI. Until today, most of the interpretability techniques have focused on exploring the internal structure of deep neural networks. But *machine behavior* [10] relies more on observations than on engineering knowledge in order to understand the behavior of AI agents. Most of the conclusions obtained from observations in nature are not related to knowledge from biology, but rather to our understanding of social interactions. In the case of AI, scientists who study the behaviors of different virtual and embodied AI agents are predominantly the same scientists who have created the agents themselves. But understanding AI agents must go beyond interpreting a specific algorithm and requires analyzing the interactions between agents and with the surrounding environment. In order to accomplish that, behavioral analysis via simple observations can be used as a powerful tool.

1.3 Machine behavior

Machine behavior [10] is a field that leverages behavioral sciences to understand the behavior of AI agents. Currently, scientists who most commonly study the behavior of machines are computer scientists, roboticists and engineers who have

[2] http://www.botmag.com/the-evolution-of-a-roboticist-mark-tilden/

created the machines in the first place, but they are typically not trained behaviorists. Similarly, even though behavioral scientists understand those disciplines, they lack the expertise to understand the efficiency of a specific algorithm or technique. From that perspective, machine behavior sits at the intersection of computer science, engineering, and behavioral sciences, in order to achieve a holistic understanding of the behavior of AI agents. As AI agents become more sophisticated, analyzing their behavior is going to be a combination of understanding their internal architecture (the domain of computer scientists), as well as their interaction with other agents and their environment (the domain of behavioral scientists). While the former aspect will be a function of deep learning optimization techniques, the latter will rely partially on behavioral sciences.

In developing a new transdisciplinary science, which we call *AI behavioral science,* we, as many others researchers, use Nikolaas Tinbergen's work [11] for identifying the key dimensions of animal behavior. Tinbergen's thesis was that there were four complementary dimensions to understand animal and human behavior:

1. **Mechanism:** The mechanisms for generating the behavior of AI agents are based on its algorithms and the characteristics of the execution environment.

2. **Development:** The behavior of AI agents evolves over time. Machine behavior studies how machines acquire (develop) a specific individual or collective behavior.

3. **Function:** Understanding how a specific behavior influences the lifetime function of an AI agent.

4. **Evolution:** AI agents are also vulnerable to evolutionary history and interactions with other agents. They can be reused in new contexts, both constraining future behavior and making possible additional innovations.

Despite fundamental differences between AI and animals, machine behavior borrows some of Tinbergen's ideas to outline the main types of behavior in AI agents. Machines have *mechanisms* that produce behavior, undergo *development* that integrates environmental information into behavior, produce *functional consequences* that cause specific machines to become more or less common in specific environments, and embody *evolutionary histories* through which past environments and human decisions continue to influence machine behavior. An adaptation of Tinbergen's framework to machine behavior is schematically presented in **Figure 1**.

Four Tinbergen's dimensions [11] provide a holistic model for understanding the behavior of AI agents. However, these four dimensions do not apply in the same way with respect to whether we are evaluating a classification model with a single agent, or with hundreds of agents. In that sense, machine behavior applies the previously mentioned four dimensions across three different scales:

1. The first is **Individual Machine Behavior:** this dimension of machine behavior attempts to study the behavior of individual AI agents by themselves. There are two general approaches to the study of individual AI agent behavior. The first focuses on profiling the set of behaviors of any specific machine agent using a within-machine approach, comparing the behavior of a particular machine across different conditions. The second, a between-machine approach, examines how a variety of individual machine agents behave in the same conditions [12].

Type of explanation	Object of study	
	Dynamic view Historical (evolutionary) view	**Static view** Current behavior of a machine
Proximate view of individual type of machine functions	**Development (Ontogeny)** Developmental explanation how machine (AI) acquires its different type of behavior with learning in a particular environment.	**Mechanism (Causation)** Mechanistic explanation what behavior is and how it is constructed.
Ultimate (evolutionary) view Why individual machine behaviors as it has	**Evolution (Phylogeny)** Forces that describe why the behavior evolved and spread.	**Function (Adaptation)** The consequence of the machines behavior in the current environment.

Figure 1.
Tinbergen proposed that the study of animal behavior can be adapted to the study of machine behavior [10, 11].

2. The second scale is **Collective Machine Behavior:** unlike the individual dimension, this area looks to understand the behavior of AI agents by studying the interactions in a group. The collective dimension of machine behavior attempts to spot behaviors of AI agents that do not surface at an individual level.

3. And finally, the scale of **Hybrid Human-Machine Behavior:** there are many scenarios in which the behavior of AI agents is influenced by their interactions with humans. This dimension of machine behavior focuses on analyzing behavioral patterns in AI agents triggered by the interaction with humans.

2. Solutions, or: Why should we be optimistic?

What can be done? In trying to provide a solution, a simple example related to the notion of *proprioception* [12] can be considered. What does proprioception really mean? Proprioception could also be called *self-perception of thought*, or *self-awareness of thought*, i.e., thought, which is able to perceive its own flow, be aware of its own movement.

With proprioception, the emotional intelligence (EI) of a person (**Figure 2a**) also develops, which will change, step by step, the human historical memory, and add new elements to this historical memory on the level of intuitive thinking. By way of analogy, we can develop a similar philosophy of proprioception for AI (**Figure 2b**). We must therefore develop this awareness in every individual - human or AI; we must "change" or establish the specific way of thinking (creative, critical, and conscious thinking); and it is very important to begin this process with agents (human or AI) of the "youngest" possible age. These competences must be developed step by step, which will enable us to deal with the day-to-day needs of others, and help raise the awareness. This transformation/analogy is shown schematically in **Figure 2**.

2.1 Machine behavior and education

Before any kind of learning environment is given some sort of intelligence (see **Figure 3**), machine ethics and/or machine behavior must be built into this learning

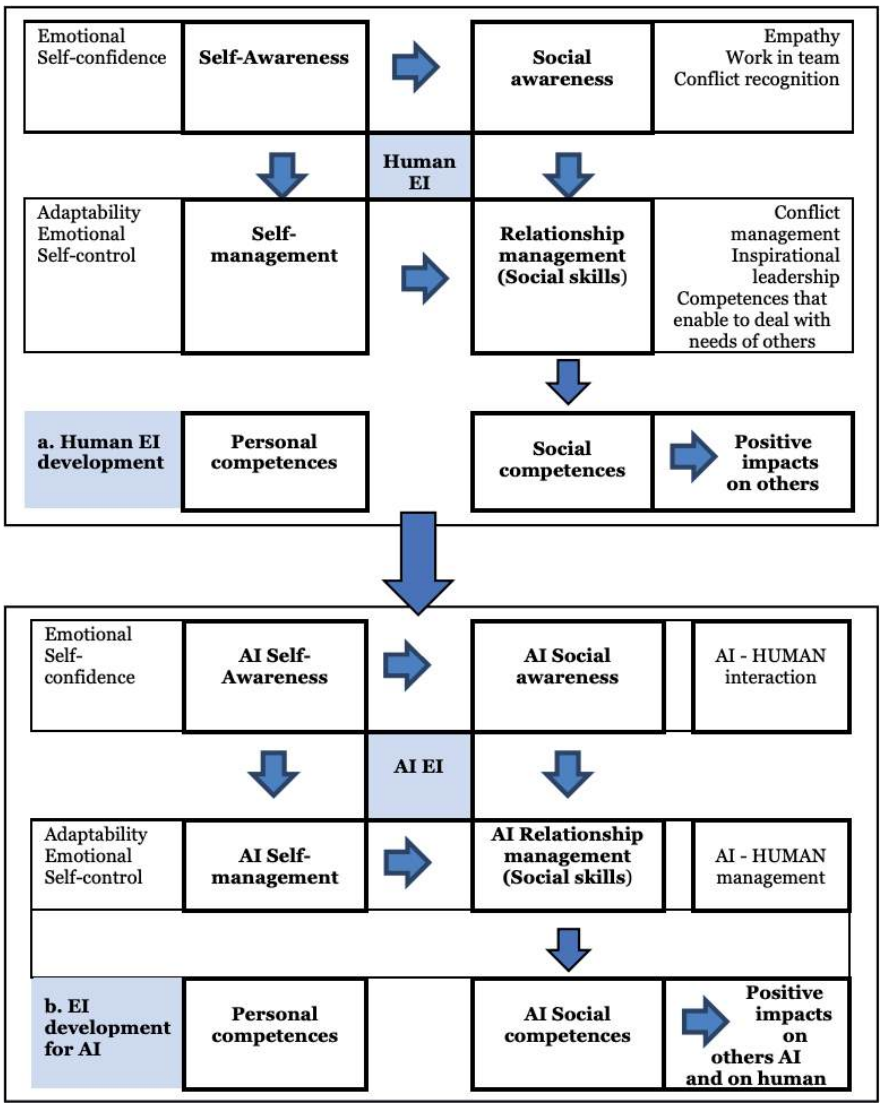

Figure 2.
From human to AI emotional intelligence (EI).

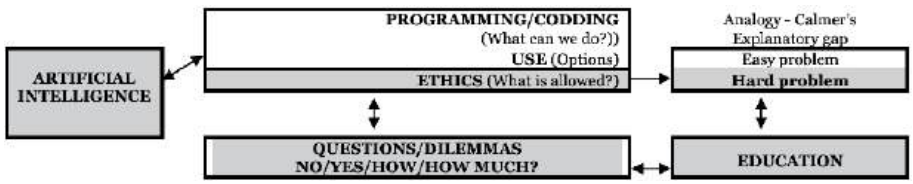

Figure 3.
Moral and ethical dilemmas in society and education.

environment, in order to ensure that the cognitive, social, and emotional competences of students are defined in a way that will allow them to be formalized or translated into a scientific language, into a language familiar to the machine.

Additionally, methods have to be defined for assessing whether such intelligent systems work correctly in the long-term, since either noticing or removing

the consequences which their failure or irregular operations have on the moral development of individuals, is not possible in real time. And since these methods, as mentioned earlier, are not in the domain of computer scientists, roboticists and engineers who have created the machines, but rather in the hands of experts from the field of behavioral science, the roles of the evaluator and the auditor must take over the role of teachers. For this reason, teachers must be able to acquire some kind of knowledge from the area of AI behavioral science in order to become competent observers and evaluators of such intelligent learning environments [13].

Additionally, methods have to be defined for assessing whether such intelligent systems work correctly in the long-term, since either noticing or removing the consequences which their failure or irregular operations have on the moral development of individuals, is not possible in real time. And since these methods, as mentioned earlier, are not in the domain of computer scientists, roboticists and engineers who have created the machines, but rather in the hands of experts from the field of behavioral science, the roles of the evaluator and the auditor must take over the role of teachers. For this reason, teachers must be able to acquire some kind of knowledge from the area of AI behavioral science in order to become competent observers and evaluators of such intelligent learning environments [13].

The general question to be answered could therefore be formulated thus: "*What are the moral problems of using advanced learning systems and modern learning environments supported by AI methods*?", with the concrete goal of the research being *the development of a test, on the basis of which teachers could assess whether an intelligent accessory (program or algorithm) for learning is such that it ensures the acquisition of all cognitive, social, and emotional competences in students*, i.e., whether it is 'safe' to use in the educational process. The development of such a test, as well as the related knowledge and skills, could encourage the development of various other similar 'security' tests for AI usage in other areas.

2.2 From smart to intelligent self-learning tutoring systems

Learning, knowledge and intelligence are closely related. Although there is no universally accepted definition of intelligence, it can be roughly defined as follows:

Intelligence is the ability to adapt to the environment and to solve problems.

Nowadays, most researchers agree that there is no intelligence without learning, so learning adaptation takes place in almost all living beings, most obviously in humans. Learning by a living system is called *natural learning*; if, however, the learner is a machine – a computer, it is called *machine learning*. The purpose of developing machine learning methods is, besides better understanding of natural learning and intelligence, to enable algorithmic problem-solving that requires specific knowledge. In order to solve problems we obviously need knowledge and the ability to use it. Often such knowledge is unknown or is used by a limited number of human experts. Under certain preconditions, by using machine learning algorithms, we can efficiently generate knowledge which can be used to solve new problems.

Even the whole natural evolution can be regarded as learning: through genetic crossovers, mutation and natural selection, it creates ever better systems, which are capable of adapting to different environments. The principle of evolution can also be used in machine learning to guide the search in the hypothesis space through the so called *genetic algorithms*.

2.3 Artificial intelligence and learning

A long-term goal of machine learning research, which currently seems unreachable, is to create an artificial system that could achieve or even surpass human intelligence. A wider research area with the same ultimate goal is called *artificial intelligence*. Artificial intelligence (AI) research deals with the development of systems that act more or less intelligently and are able to solve relatively hard problems. These methods are often based on imitation of human problem solving. AI areas, besides machine learning, are knowledge representation, natural language understanding, automatic reasoning and theorem proving, logic programming, qualitative modeling, expert systems, game playing, heuristic problem solving, artificial senses, robotics and cognitive modeling.

Machine learning algorithms play an essential role in all AI areas. One has to include learning practically everywhere. By using learning techniques, the systems can learn and improve in perception, language understanding, reasoning and theorem proving, heuristic problem solving, and game playing. The area of logic programming is also highly related to inductive logic programming that aims to develop logic programs from examples of the target relation. Also in qualitative modeling the machine learning algorithms are used to generate descriptions of complex models from examples of the target system behavior. For the development of an expert system one can use machine learning to generate the knowledge base from training examples of solved problems. Intelligent robots inevitably have to improve their procedures for problem solving through learning. Finally, cognitive modeling is practically impossible without taking into account learning algorithms.

2.3.1 Natural learning

Humans learn throughout our whole lives. We learn practically every day, which means that our knowledge is changing, broadening and improving all the time. Just like humans, animals too are capable of learning. The ability to learn depends on the evaluative stage of species. Investigation and interpretation of natural learning is the domain of *the psychology of learning* and *educational psychology*. The former investigates and analyses the principles and abilities of learning. On the other hand, the latter investigates the methods of human learning and education and aims at improving the results of educational processes. Educational psychology considers attention, tiredness and motivation to be of crucial importance for a successful educational process and carefully takes into account the relation between the teacher and the students, and suggests various motivation and rewarding strategies. All those are of great importance for human learning, however, they are much less important for (contemporary) machine learning.

2.3.2 Learning, intelligence, consciousness

As we already stated, intelligence is defined as *the ability to adapt to the environment and to solve problems*. Learning alone, however, is not enough. In order to be able to learn, a system has to have some capacities, such as sufficient memory capacity, ability to reason (processor), ability to perceive (input and output), etc. These abilities do not suffice if they are not appropriately integrated or if they lack an appropriate learning algorithm. In addition, efficient learning also requires some initial knowledge – background knowledge, which is inherited in living systems. Through learning, the abilities of the system increase, and therefore the intelligence of the system also increases [14].

2.3.3 The amount of intelligence

Systems cannot be strictly ordered with respect to the amount of intelligence, because we have to consider various types of intelligence (abilities): numerical, textual, semantical, pictorial, spatial, motor, memorial, perceptive, inductive, deductive, etc. Lately, even emotional intelligence became widely recognized. Some authors describe more than a hundred types of human intelligence. A system (human or machine) can be better in some types of intelligence and worse in others, and vice versa. When speaking about artificial intelligence, we do not expect an intelligent system to be extremely capable in only one narrow aspect of intelligence, such as for example the speed or the amount of memory, the speed of computation or the speed of searching the space or (almost optimal) game playing. The computers of today already have very advanced capabilities in each of these aspects. We expect an intelligent system to be (at least to some extent) intelligent in *all* areas which are characteristic of human problem solving. It seems that we need an integration of all different types of intelligence into a single sensible whole (a kind of supervisory system), so that during problem solving it is possible to switch appropriately between different types of intelligence. Anyway, most of the speculations about artificial intelligence do not take into account yet another level: consciousness (which seems to be a good candidate for the supervisory system).

3. Education 4.0 in society 5.0

The use of contemporary learning strategies, such as games, research-based and problem-based learning connected to collaborative teaching/learning, and brain-based techniques based on cybernetics theory and information-communication technologies, have provided scholars from diverse disciplines with an unusual opportunity to observe possible flaws in their own thinking [12, 15, 16]. The choice of method was crucial: if we were to report results obtained only through conventional, standard behavioristic methods, our work would have been less noteworthy, less critical, and less memorable. This is why we did not choose demonstrations over standard methods, because we wanted to influence the entire spectrum of audiences. We preferred *problem-based and research-based methods* and *collaborative learning*, because they were more fun for students, and we were lucky in our choice of method, as well as in many other ways. We used the *brain-based technique* because it provides the educator with an understanding of what happened, and of how to react during the lecture. And we proposed intelligent serious games and game-based learning because they increase motivation.

The spontaneous search for intuitive solutions to complex problems, such as for example ecological problems, or today's global pandemic problem, sometimes fails – neither an expert solution, nor a heuristic answer comes to mind. The responsibility of the teacher is to equally develop all ways of problem solving, critical thinking, and decision-making, by choosing appropriate research problems and using a transdisciplinary model of teaching [15].

There is a huge number of opportunities to introduce novelties like the proposed problem- and research-based learning in the learning process simply by being creative; for instance, the teacher can use fresh examples or problems, or surprise students with new data, or present a scenario that is completely unpredictable. The teacher can also engage students through games and simulations that require them to apply the information in unfamiliar contexts. E-learning environments, role play, energizing online discussions, and quick serious games, can all add sensory stimuli to raise the blood pressure and epinephrine levels to eliminate drowsiness, reduce restlessness, and reinforce information. Allowing learners to do some research and

exercises on their own to better understand abstract ideas, write an essay, or work with an interactive simulation, are also helpful strategies.

3.1 Cybernetics, learning and AI

The purpose of this chapter is to complement the preceding ones, changing the focus from the dynamics of social systems to that of individual human systems and developing their emotional intelligence (EI). It will be seen that second-order cybernetic 4.0 systems study self-observing systems, which are comprised by *cognitive machines*, information processing mechanisms that reside in the human mind [17].

The idea of rationality as a *cognitive machine* that has as its purpose though coherence will be offered as the staple of second-order cybernetics 4.0; another aspect of it will be that of heuristics, not only as practical reasoning but as ways of conceiving and understanding the world. The framework that will be offered will consist of the understanding of patterns (order), their proportion (balance) and harmony as their functional conjunction; constructive epistemology will also be delved upon in order to create a complete perspective upon human psychic systems.

Finally, the ideas of second-order cybernetics 4.0 will culminate in the idea of social and cognitive morphogenesis as heuristics is related to measures of complexity: order will be related to hierarchy, balance to self-similarity and harmony to universality; it will be concluded that repetition is the most adequate measure of complexity in social systems.

3.2 Brief description of second-order 4.0 cybernetic pedagogy

3.2.1 Points of contact between second-order and second-order 4.0 cybernetics

Self-consciousness is the point of transition between lower cognition (knowledge and lower levels of cognition without any emotional intelligence (EI) components which pertain to second-order cybernetics) and that which belongs to human beings, i.e. high cognition (developing cognitive and social competences, which is the object of study of what will be called second-order 4.0 cybernetics). The latter is referred to as a high cognition model because of the self-consciousness that a system can acquire through self-observation, and thus become teleonomical and teleological. Before entering the study of second-order 4.0 cybernetics, it is necessary to further develop the notion of cognition, so that the analysis will be complete.

Let us start with the pioneer of the psychological theory of cognitive development and learning, Piaget. In his widely known psychological research, Piaget makes a typology of the cognitive development of a human being from birth to adulthood:

- *Sensorimotor stage* (from birth to a year and a half, two): the first motor reflexes develop, along with first instincts and emotions, there is also a development of a sensory-motor intelligence prior to language. Knowledge starts developing on the basis of experiences/interactions; some language skills are developed at the end of this stage.

- *Pre-operational stage* (from two to seven years): language skills are present, intuitive intelligence develops, there is a submission to adults and spontaneous intersubjective feelings; memory and imagination are developed.

- *Concrete operational stage* (from seven to twelve years): logical and systematic intelligence blossoms, along with moral and social sentiments of cooperation;

manipulation of symbols related to concrete objects; operational thinking predominates.

- *Formal operational stage* (adolescence to adulthood): abstract intellectual operations appear, personality forms and there is an affective and intellectual insertion into adult society.

If we disregard that children over the past few decades have been growing up in significantly different circumstances, and have developed differently on account of an increased access to information, we can still use Piaget's findings as the starting point for the further development of second-order 4.0 cybernetics pedagogy.

Every state is distinguished from the preceding one because of the appearance of new original cognitive structures. In this typology, the difference between lower and higher cognition can be seen more clearly: while in the sensorimotor there is motor activity, knowledge based on experience and interaction and limited language acquisition, in the formal operational stage an individual can communicate with others by means of a symbol system, they are capable of logical and abstract reasoning and start to develop their emotional intelligence. This is the transition between lower cognition in animals and primates who possess it alongside a limited ability for self-observation, and human beings, which are capable of higher cognition by means of language, abstraction and formal reasoning. Higher cognition has already been defined, but a reprisal of the concept is useful: it is the processing (storage, retrieval, transformation, creation and transmission) of information made by an autopoietic system in its interaction with what surrounds it (environment and other beings) with the possibility of stating a purpose beyond self-sustainment.

3.2.2 Second-order 4.0 cybernetic pedagogy as the realm of self-observing systems

Second-order 4.0 cybernetic pedagogy exhibits features of both first- and second-order cybernetic machines. Second-order 4.0 cybernetics studies cognitive machines (in our case the tutoring system as a universal meta-model), information processing mechanisms of the high order that have their basis within the neural network of human beings, that is, it is the cybernetics of human beings transforming the human being's reaction and/or activities in AI form, to build intelligent tutoring systems (ITS). There are many cognitive machines that make up higher cognition, however, the one to be pre-eminently studied by this branch of cybernetics is rationality, understood as a mechanism which allows the development of coherence within the thought system and also its relationship to language, understood as the cognitive machine that complements rationality and also the one that allows the bridging of cognitive systems, thus fostering socialization. The high degree of flexibility of human cognition requires that we think of much of the human cognitive architecture not as determining specific thoughts and behaviors but as an abstract set of mechanisms that potentiates a vast range of capabilities.

The following can be stated as reasons for the development of a new version of second-order cybernetics 4.0:

- to introduce a new paradigm shift,

- to address an explicit discussion of the human system, including the problem of teaching and learning and

- to develop a model to demonstrate how structure and context influence such systems.

Although there are resonances between Mancilla's [17] notion of fourth-order cybernetics and the one advanced in this study (second-order 4.0 cybernetics), the main difference between them lies in their approaches: the former adopts a psychological, post-modern approach as well as the requirements of the industry 4.0, which assimilate cybernetics into this discipline and school of thought respectively, while the latter attempts not an interdisciplinary approach, but a transdisciplinary one, i.e., it attempts to develop a model that does not fit within the boundaries of a specific branch of social sciences, but one that respects the basic tenets of cybernetics.

3.2.3 Cognitive machines

When we talk about cognitive machines, we talk about *programmed learning* (or *programmed instruction*) which is a research-based system which helps learners work successfully. The method is guided by research done by a variety of applied psychologists and educators. Anticipating programmed learning, Edward L. Thorndike wrote in 1912:

> *If, by a miracle of mechanical ingenuity, a book could be so arranged that only to him who had done what was directed on page one would page two become visible, and so on, much that now requires personal instruction could be managed by print.*

On the basis of these premises Skinner developed programming learning, the theory of programmed instruction (programmed sequences), which he proposed as early as 1958 [18]. According to Skinner, the basic and most important goal of programmed instruction *is to carry out learning in a controlled environment.* His scheme of programmed instruction was to present the material as part of a "schedule of reinforcement" in typical behaviorist manner. The programmed text of Skinner's theory of behaviorism is the most complete example of his ideas in action. Skinner's system was generally called "linear programming" because its activities were placed in otherwise continuous text. He laid the foundations of this instruction, which should pursue three mainly objectives:

1. It should provide information in smaller (substantive) sets,

2. it is intended for self-learning and

3. provides immediate background checks and feedback to the learning.

Today's learning systems could be built on the same basic idea, although the range of possibilities for preparing such learning environments is much wider. Whenever we refer to AI in this book, we will be referring to intelligent teaching/learning environments, and usually we will use the term intelligent tutoring system (ITS).

Two questions are to be asked in order to understand todays model-ITS as a universal meta-model or cognitive machine:

- first, what are the elements that constitute such mechanisms? (We are talking about the architecture or structure of such systems).

- Second, what are the defining features of a cognitive system? (We are talking about the function of such systems).

As it was already mentioned, there are three requirements to be fulfilled in order for a machine to be considered as cognitive:

- it must store and retrieve information,
- it must help to understand received information, and
- it must create new information.

The defining features of cognitive machines can be expounded by analyzing their relation to their inputs and outputs. Cognitive machines receive, create, transform and transmit information, which is both their input and output, and which can be used either to create new data, different from that received or to broaden the existing information storage in the brain. This can result in the expansion of the cognitive domain. This means that cognitive machines are omnipoietic because they can produce both their own components and other information; omnipoiesis, the

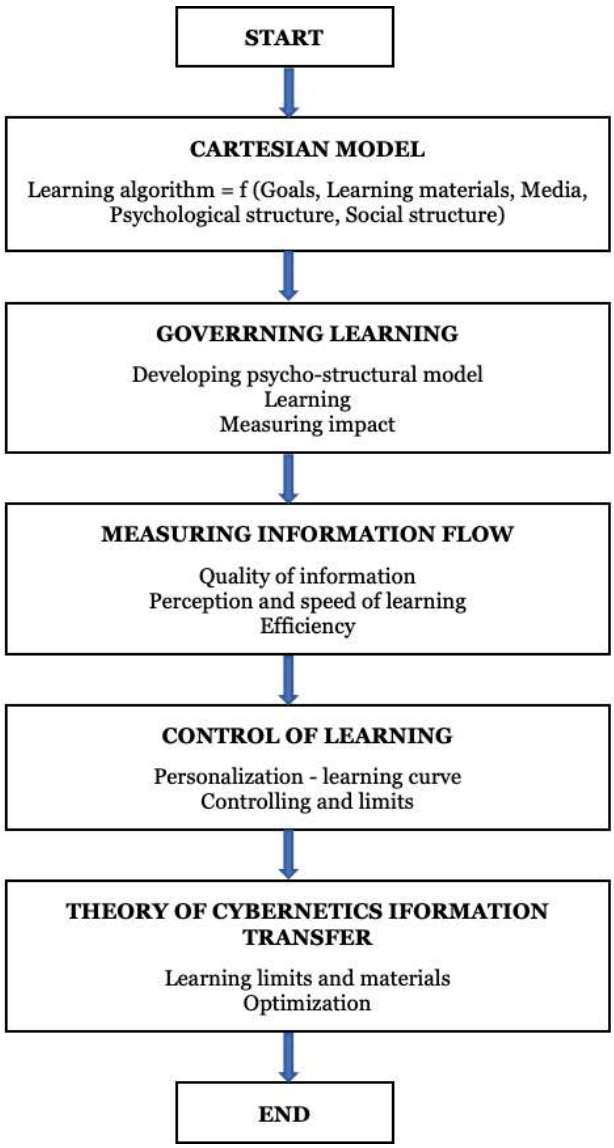

Figure 4.
Algorithm of a cybernetic learning system.

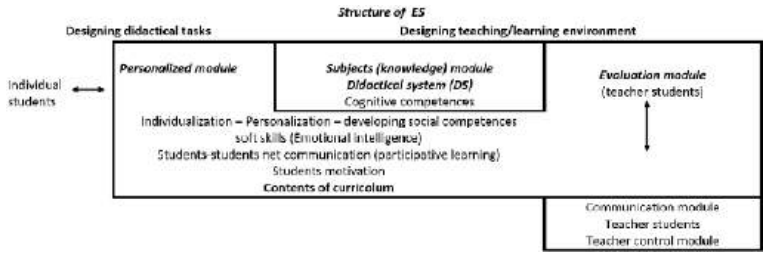

Figure 5.
LMS_AI.

ability to create all kinds of output (internal and external to self) is the distinguishing feature of cognitive machines, which are the subject of study of our second-order 4.0 cybernetic system.

3.3 Second-order 4.0 cybernetic learning algorithm

Let us now transfer these theoretical findings onto a concrete example of modern innovative learning environments. **Figure 4** shows an algorithm for a cybernetic learning system (universal meta-model) on the basis of *second-order 4.0 cybernetic systems* and the *didactics of learning theory 4.0* [12].

3.4 Education 4.0 - case study: (ITS) based on intelligent solution: LE_LMS_AI

On the basis of the presented theory and the algorithm in **Figure 4**, we present (see **Figure 5**) an intelligent tutoring system ITS (a learning management system or LMS) based on second-order cybernetic pedagogy 4.0 and AI solutions. We named it the *LE_LMS_AI.* The LE_LMS_AI is heuristically based on a hybrid cybernetic second-order system 4.0. Since the educational system is a complex, multidimensional, non-linear and dynamic system, our findings will be presented using a simplified concrete example.

4. *General description of the* LE_LMS_AI

Based on the concept shown in **Figure 5**, we developed the LE_LMS_AI, consisting of three permanent system modules (the personalized module, the evaluation module, and the communication module) and one module relating to the subject matter at hand (the subject module), which can be independently adapted and/or altered by the teacher. The basic functions of the individual modules are as follows:

The *personalized module* (PM) is a connecting system between the individual learner and the learning system LMS_AI. It is a link between the teacher and the learner, as well as a link between the learners themselves during their engagement in participatory classes. The PM is closely linked to the evaluation module (EM). Its primary task is to adapt the learning path to an individual learner (individualization and personalization), to determine their initial state (the level of knowledge about a particular topic (learning content) and the learner's attitude regarding this topic), to monitor their progress and adapt the learning path to their needs (e.g., their learning style) and abilities (differentiation). Since both system modules are AI-based, this module is used to store the personal data of an individual, for whom the learning system has been adjusted already at the beginning by modifying the subject module (SM), in order to fit his/her needs and abilities, as defined during previous lessons (i.e. previous SM). If at the beginning of the school year the

LE_LMC_AI is the same for all students, at the end of the school year we will have as many different LE_LMC_AI as there were students in the class. They will have all achieved the same learning goals and met the same learning standards, however, they will have reached these goals through entirely different paths.

The e*valuation modu*le (EM) is a module based primarily on AI methods. Its basic purpose is to:

1. analyze the existing condition of
   - the students' knowledge (the cognitive component) and
   - the decisions, the awareness (the social component, emotional intelligence) of an individual student.
2. and forward the results of these analyses to
   - the teacher, who can thereby monitor the progress in individual students (formative assessment),
   - the student, for the purpose of self-evaluation and motivation, and
   - the system, i.e. to the personalized module (PM), with the intent of individualizing and personalizing the learning path for the individual student.

The basic scheme of this module is shown in **Figure 6**.

The *subject module* (SM) is a module related to a specific subject, i.e., to the concrete teaching/learning content. This module consists of several elements (blocks) and is founded on the idea of brain-based teaching/learning. The module is shown schematically in **Figure 7** (below). The individual learning contents (activities) are divided into learning units with the duration of approximately 45 to 90 minutes, consisting further of blocks in the duration of 10 to 20 minutes. Such modules can be organized for individual subjects as a whole (intelligent i-textbooks), or they can be organized for individual problems or projects, which are stored in a database and are accessible to teachers as a teaching aid. The modules are set up on the basis of concrete examples/learning situations to facilitate individual problem- or research-based work in students engaged in formal (here, the modules serve as a teaching aid to the teacher) or non-formal types of learning (self-learning, reinforcing knowledge, homework assignments, etc.). These modules represent the flexible part of the LE_LMS_AI, which can be adapted or complemented to meet the existing needs and/or requirements (e.g. a change in the curriculum). A schematic representation of such a module is shown in **Figure 8**.

The basic structure of individual blocks is shown in **Figure 8**.

It is necessary to emphasize, as is apparent from **Figures 6** and **7**, that two processes take place simultaneously within an individual block, and that we are thus tracking:

- the cognitive process (knowledge, understanding) and
- the socialization process (relationships, emotional intelligence).

Each SM is built hierarchically, which enables a differentiation of the knowledge acquisition path, and is automatically adapted to the individual learner. In theory, three levels are anticipated (high, medium and low), while the possibility of

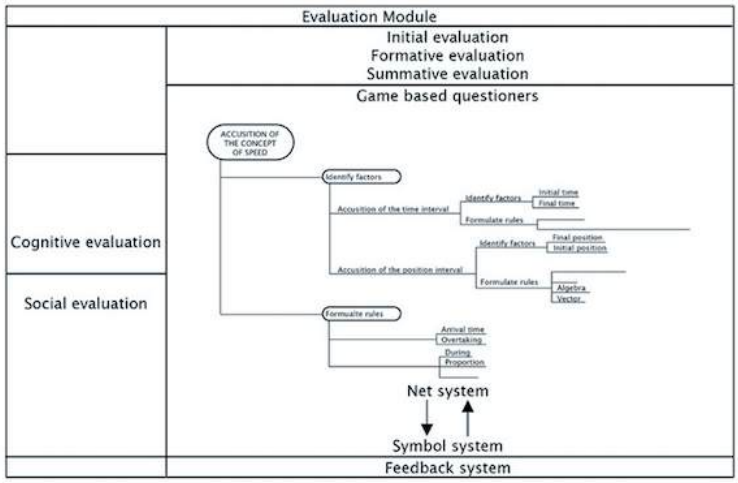

Figure 6.
Evaluation module.

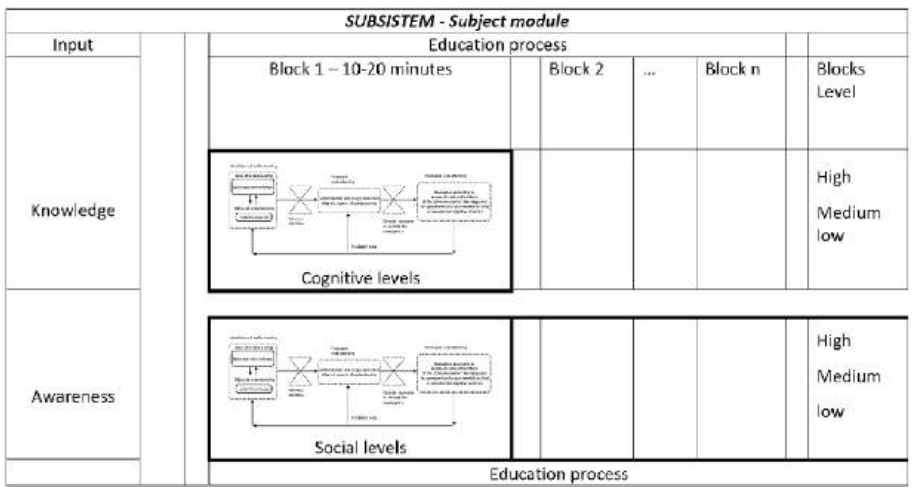

Figure 7.
Subject module.

employing AI methods would eventually result in a "complete" personalization of the learning paths. The SM are divided into three groups, depending on the difficulty level of the learning content, and on the ways and methods of acquiring this content, namely:

- for lower cognitive levels, which are related to the elementary acquisition of basic knowledge (memorizing), and where traditional (frontal instruction, transmission approach) forms of teaching are used as the teaching method, the LMS_AI is intended mainly for teachers in the preparation of classes;

- for lower cognitive levels, learners use it mainly to reinforce their knowledge. This module includes various learning strategies, especially game-based techniques, used to increase the motivation and interest of students. By means of this, the teacher can formatively monitor the individual students' progress and adjust subsequent lessons accordingly.

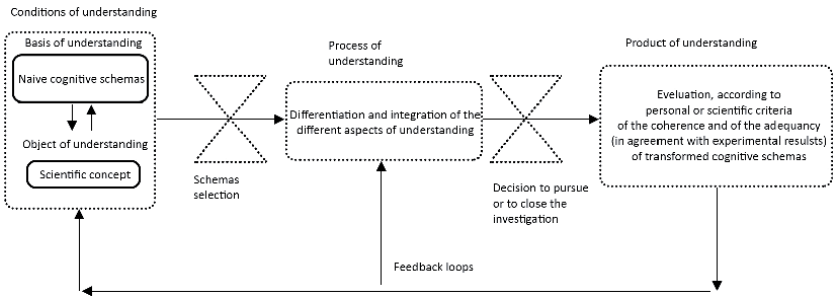

Figure 8.
The structure of the SM block.

- for higher cognitive levels, the LE_LMS_AI can be used predominantly as a self-learning tool for the student, supported by the teacher's research-, problem-, or project-based working methods. In this kind of situation, the teacher only appears as a tutor, as the one who provides guidelines and encouragement to the students involved in the learning process. In this kind of process, students are active, curious, and motivated.

The *communication module* (CM) is the link between users (students) and the learning system. It is a module that enables data input, and communication, both between teachers and students, as well as between students and the ITS.

4.1 Other possibilities of using AI in education

4.1.1 Student evaluation

An intelligent program can automatize an entire process of evaluation and unburden the teacher, enabling them to focus on qualitative aspects of lessons. Since the efficiency of machine learning increases proportionately with the expansion of the database, the evaluation of students from the quantitative aspect would not be disputable. The possible mistakes could be corrected by the teacher, and the intelligent system could use this to learn. The time that the teacher would gain with the automatization of evaluation could then be spent for interaction with students, preparing for lessons, or career development, nonetheless leaving her enough time to examine the correctness of the grades, and this would represent the mentioned fail-safe. However, we must be cautious of unpredictable deficiencies of such an approach: the automatization of evaluation may, for example, include the traces of bias and therefore lead to unjust or unrepresentative grades.

4.1.2 Individualization of learning

Intelligent devices are essentially devices the user interface of which and interaction with them are highly individualized. The presence of teaching tools of AI in the educational process will reinforce this aspect of communicating with the world. With the help of intelligent accessories, learning will also become individualized, for the intelligent system can respond to students' needs, focus on certain topics, insist on revising a subject, and determine the learning speed. Here, the question of the goal of such learning arises. Does this program enable, through individualization, the students to develop the necessary cognitive, social and emotional competences:

does it, for example, teach them to be active citizens and not passive consumers? Undoubtedly, the individualized and regularly adjustable learning is a significant pedagogical step; however, it includes certain aspects that need to be analyzed and evaluated, so that the inevitable implementation does not lead to unwanted consequences.

4.1.3 Improvement of seminars

Drawbacks of a seminar are not always obvious, and AI may help teachers to uncover them. *Coursera* is an online seminar platform that is already practicing this. When there is an occurrence of a greater number of students submitting incorrect answers in homework, the system warns the teacher and prepares an individualized message for future students, which contains a hint as to the correct answer. Such an approach helps to eliminate a pedagogical gap and ensures that the students get the immediate feedback which helps them to understand a difficult concept.

4.1.4 Searching for information

We seldom pay attention to the AI systems that customize information for us every day. The customization parameters are based on, for example, locations (Google), purchase history (Amazon), or our needs and demands (Siri). Almost all online advertisements are tailored according to our interests and buying preferences. These intelligent systems have a significant role in how we interact with the internet and information in our professional and private lives. And why should matters be any different in the educational process? Here, too, exists the possibility of customizing information that we use for learning. Current generations of graduates have a radically different approach to research compared to their colleagues from a few years ago. The use of new intelligent accessories in education can increase the impact of the customization of information, and that is why it is even more important for us to be capable of correctly assessing their developmental adequacy [19, 20].

5. Conclusion

Machine behavior is one of the most intriguing, nascent fields in AI. Behavioral sciences can support traditional interpretability methods in developing new methods that will help to better understand and explain the behavior of AI. As the interactions between humans and AI become more sophisticated, machine behavior might play a crucial role to enable the next level of hybrid intelligence. From all of the above it can be concluded that at least the following three guidelines should be taken into consideration, especially with respect to using intelligent learning environments in education:

1. Not every kind of AI is a benefit to mankind, and not all uses of AI are ethical and moral.

2. The ethical use of AI should be judged not only by computer scientists, roboticists and engineers, but (especially) by behavioral scientists.

3. Teachers need to be trained (empowered) and provided with appropriate competences to assess the usefulness and ethical use of AI.

Acknowledgements

"The authors gratefully wish to acknowledge to the Ministry of Education, Science and Sport of the Republic of Slovenia, and European Social Found. This work would not be possible without the support for the project "Innovative learning environments supported with ICT: Innovative Pedagogy 1:1".

The authors wish to express their appreciation to all those who have ensured the quality of this book. Last but not least, thanks to our children and partners, who have inspired us, supported us, and given us the opportunity to be who we are.

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Chapter 7

Technology Enabled Active Learning in Electrical Engineering

Syed Abdur Rauf Magrabi

Abstract

Educational technology supports meaningful learning and enables the presentation of spatial and dynamic images, which portray relationships among complex concepts. The Technology-Enabled Active Learning (TEAL) involves media-rich software for simulation and visualization in freshman Electrical Engineering carried out in a specially redesigned classroom to facilitate group interaction. These technology-based learning materials are especially useful in safety procedures in transformers in electrical engineering to help students conceptualize phenomena and processes. This study analyzes the effects of the unique learning environment of the TEAL on students' cognitive and affective outcomes. The assessment of the project included examining students' conceptual understanding before and after studying safety procedures in electrical engineering in a media-rich environment. We also investigated the effect of this environment on students' preferences regarding the various teaching methods. As part of the project, we developed pre-test and posttests consisting of conceptual questions from standardized tests, as well as questions designed to assess the effect of visualizations and experiments. It consisted of a small- and a large-scale experimental groups and a control group. TEAL students improved their conceptual understanding of the subject matter to a significantly higher extent than their control group peers. A majority of the students in the small-scale experiment noted that they would recommend the TEAL course to fellow students, indicating the benefits of interactivity, visualization, and hands-on experiments, which the technology helped enable also about teaching learning process for building students confidence is discussed. In the large-scale implementation students expressed both positive and negative attitudes in the course survey and feedback is also mentioned.

Keywords: technology enabled active learning (TEAL), active learning, teaching and learning process

1. Introduction

Active learning requires students to develop their understanding of content through the active construction of product, the solving of a problem or both embodies a long human tradition of learning through doing [1]. Active Learning refers to any strategy or activity where the responsibility of learning is placed on the learner and secondarily on instructor. It emphasizes learning, not teaching. In active learning strategy, students learn by directly engaging in the material they are studying through reading, writing, discussing etc. There is much research going on, educators have been talking over 30 years about active learning. In that

process they have come up with a definition of active learning which is stated as an instructional method in which students actively participate in their learning process via learner-centered activities that exercise the higher order thinking skills of analysis, synthesis and evaluation rather than passively listening to a lecture. Instructors should know that the learner is a unique individual, variations in the culture and background of the learner. As the learner progresses he or she should take increasing responsibilities for his/her learning. Active leaning is a highly effective approach to teaching at the university level. Instructional strategies for active learning can take many forms, including writing, role-playing, gaming, constructing, experimenting, simulating, observing, and discussing. Active learning occurs when students participate in their own learning, no matter what specific activity is involved. Active learning is thinking made visible, with evidence of analysis, synthesis, and evaluation. It goes beyond passive listening, memorization, and recitation. The unique characteristics of digital technologies can enhance – intensify, increase, amplify – active learning. Open source software, web apps, common digital cameras, and almost ubiquitous mobile technologies empower and engage students as they construct, build, create, and distribute products that represent and reinforce their learning. These technologies provide opportunities for simulation, experimentation, research, and self-expression. In turn, social media exponentially improve access: access to information, to opportunities for collaboration, to alternative perspectives, and to audiences for student-generated products [2]. Flipped classroom technique has changed my perspective towards teaching and learning process. For the first time, I have come out of myself and watched my class from student point of view. Out of all teaching and learning techniques so far I come across, I feel Active Learning technique has found to be an effective method of teaching the course I am handling now to my students. In my previous years of teaching experience, I used to follow pedagogical approach by teaching detailed explanations about various concepts and dictate the important points to the students. After undergoing various training programs and attending various workshops on teaching engineering education such as the one I am undergoing now, I have realized that only advanced learner can understand my teaching abilities. Even an average learner will get bored and lose concentration and interest on my teaching. In order to bring maximum attentiveness and create interest in students and their learning, I should be able to adopt Active Learning technique to teach engineering course to group of students various cognitive levels. A visual and sequential style of teaching followed by creating an Active Learning environment in the classroom could help the students gain more knowledge and interest in learning. Flipped classroom technique can be adopted to teach some of the topics in Electromagnetic course such as Properties dielectric materials, Gaussian laws, Poisson Equations, Maxwell's equations etc. While discussing about properties of dielectrics I can throw some questions for students by explaining some case studies. For example, while teaching a property of permeability such as density, relative density and surface boundaries. Also they can be asked to explain the phenomenon of capillary raise in tubes of very small diameters, non-mixing of some fluids such as oil and water etc. The topic of flow through pipes can be taught more interestingly by making them to conduct small experiments on branched pipes and how the discharge could be affected. I will also ask the students to divide into groups in order to allow each group to conduct a suitable experiment for understanding the concepts and phenomena and prepare a video on the experiment they will conduct. Also they can be asked to make a pipe with bends and small enlargements and contraction to estimate the loss of head due to various major and minor losses such as bends, sudden enlargement, sudden contraction, friction etc.

It is obvious that online teaching/learning is a proven successful technique to teach engineering education. Still there are some obstacles and hindrances in attaining effectiveness. This could be suitable platform for student community who has high degree of dedication and self-discipline. As it becomes difficult for the teacher to assess the state of level of understanding of the student, online courses are less efficient. Also there exists a lack of credibility and individuality in submitting the assignments. As a teacher we should be in a position to know the different learning styles of students present in the class based on the we have to change our teaching style, the implementation of different teaching styles in the classroom can help us to find way for success of all students. The way a teacher presents the lecture depends on the teacher's preferences. The way a student learn does not always match with the teaching style of a teacher. Mismatches may happen and students become bored sometimes. The teacher finds difficulty in understanding the learning style of the students. In a conventional/traditional classroom the teacher can change learner's style of learning if found not suitable immediately as per the response received from the students attending that class at that moment. But in case of an online teaching/learning, the teacher will require more time to assess the learning style of the students. This is the major challenge in any online course in my perspective. There were thirteen important tricks that will help students for effective learning as [3].

1. Motivate and relate new material to previous and future topics (Sequential, Global)

2. Provide balance of concrete information (sensing) and abstract concepts (intuitive).

3. Encourage all students to exercise both sensing and intuitive learning etc.

4. Encourage cooperative learning of home work.

5. Pause to allow time for reflection.

6. Use computer assisted instructions.

7. Plan active learning strategies suh as 5-minute brain storming.

Critical Thinking Attributes	**Teaching/Learning Activities**	**Challenges for Critical Thinking**
Look for multiple answers, elucidations, opinions, options, solutions	Use multiple case studies, programs, examples that illustrate variation, comparison and connection	Examine students to generate multiple opinions, views, solutions, investigation in projects/assignments
Evaluate assess concept, planning, methodology, solutions	Taking risk (by implementing various strategies to design an IOT project)	Give feedback (every day, every week) but the process to be continuous to make the students gets satisfaction of what they are doing
Independent and creative thinking	Inductive teaching rather than deductive teaching	Provide students with necessary information and data or material for which they can identify the problem and give various solutions

Table 1.
Shows the attributes on critical thinking towards Teaching & Learning Activities & challenges.

8. Assign some drills for practice and some problems requiring analysis.

9. Encourage creative solutions.

10. Talk students about the learning styles, during advising in the class.

11. Use pictures, schematics graphs etc. before during and after verbal is shown.

12. Prove concrete examples described by theory.

13. Balance practical problem solving with fundamental understanding.

Concept on Critical thinking by the use of technology.

Faculty must poses to solve problem critically the first thing is reasoning, evaluating the data or any analytics, problem solving skills, decision making and analyzing this process can be done as individual work or a collaborative work/group work. The below **Table 1** shows the relationship between critical thinking attributes, teaching/learning activities and challenges for critical thinking.

2. Strategies to think critically

There are various strategies to think critically and most of this work may or may not be only individual role but can be seen in group course work/project work in collaborative manner.

- Continuous discussion between faculty and students
- Analyzing the problems through case studies and providing necessary solutions
- Reading lecture material and referring to research articles from reputed journals
- Use of software's to trace and track problems wherever encountered in designing and building files
- Summarizing the concepts gathered from the date of project given
- Identifying the types of components to be used and to list the working principles of those components
- Asking question between different groups and teams members
- Resources/materials/data sheets to be used for the products
- Enumerate the possible aspects of outputs and results
- Instructors need to show some involvement when the students get stuck completely and making them to understand the situation and showing ways to rectify the problems in their projects for real time applications.
- Online/offline mode of discussion between students-student's interaction, faculty-student interaction etc.

- Self-correctness for identify, analyzing and summarizing between theoretical and practical concepts.

- Should poses the caliber to manage time using GNATT chart, PERT-1 chart, and PERT-2 chart or must take advice from guide or supervisor for time management between regular classes and project works (mini and major project).

How to ask the right questions?

Asking the Right Questions: Critical thinking is best supported when instructors use critical questioning techniques and demonstrating the live projects on IOT to engage students actively in the learning process.

Sample questions from all these studies include the following:

- What do you think about this?

- Why do you think that?

- What is your knowledge based upon?

- What does it imply and presuppose?

- What explains it, connects to it, leads from it?

- How are you viewing it?

- Should it be viewed differently?

These questions require students to evaluate the clarity and accuracy of their thinking as well as the depth and breadth of their thinking. Have they considered all the alternatives? Do they know why they think the way they do? Students need to determine whether the content they are using is relevant and if their thinking process is logical. By questioning their thought process, students can begin thinking about their thinking. Research on questioning methodology also suggests that instructors should wait for student responses too often the students' silence is filled by the instructor re-wording the question or asking a different student for a response. However, most students need at least 8 to 12 seconds to process and formulate their response, especially in critical thinking situations. If a question is based on rote memory recall, speed may be relevant; however, thinking requires time and patience. Give students the time they need to think critically [4].

The 21st century essential skills includes:

1. Personal and social responsibility

2. Planning, critical thinking, reasoning and creativity

3. Strong communication skills, both for interpersonal and presentation needs

4. Cross-cultural understanding

5. Visualizing and decision making

6. Knowing how and when to use technology and choosing the most appropriate tool for the task [5].

3. Active learning benefits and teaching learning process

Active Learning.
The benefits of Active Learning are as follows:

- Students are more likely to access their own prior knowledge, which is a key to learning.
- Students are more likely to find personally meaningful problem solutions or interpretations.
- Students receive more frequent and immediate feedback.
- The need to produce forces learners to retrieve information from memory rather than simply recognizing a correct statement.
- Students increase their self-confidence and self-reliance.
- For most learners, it is more motivating to be active than passive.
- A task that one has done himself/herself or as part of a group is more highly valued.
- Student conceptions of knowledge change, which in turn has implications for cognitive development.
- Students who work together on active learning tasks learn to work with other people of different backgrounds and attitudes.
- Students learn strategies for learning itself by observing others [2].

The benefits of active learning are widely acclaimed in higher education. According to Guthrie and Carlin (2004), modern students are primarily active learners, and lecture courses may be increasingly out of touch with how students engage their world. Chickering and Gamson (1987) early proponents of active learning, designated "encourage active learning" as one of seven principles of good practice in higher education. Clickers offer one approach to employing active learning in the classroom. They are more formally denoted as Student Response Systems (SRS), Audience Response Systems (ARS), or Personal Response Systems (PRS) (Johnson, 2004). Clickers allow students to participate in classroom activities, regardless of class size and common student dynamics. These remote-like gadgets transmit individual student responses to an instructor's computer to record and even share these results directly back to the class. Instructors can also use this data to customize their lessons for each learning group (Kenwright, 2009). Johnson (2004) describes how clickers address three of Chickering and Gamson's (1987) seven principles for good practice in undergraduate education, as follows [2]:

- Actively engage students during the entire class period.
- Gauge their level of understanding of the material being presented.
- Provide prompt feedback to student questions.

4. Teaching learning process

The article written by R. Felder and L Silverman is gave me a thoughtful idea on implementing different learning styles and then to relate it on teaching style.

As it basically happens with me that when I teach students hear me out but what's the outcome of it students just make notes/clearing exams do they really obtain necessary knowledge which they can implement in their real time application and could they become that much confident in the ever changing competitive world. I teach a subject which is more practical oriented rather than theoretical and yes my learning style always influenced my teaching style. The mode of learning style which merely I adapt is Sensing Learning (Sensing Learners) though I acquire visual learning, active learning and I am more enthusiastic in blended learning by using CANVAS, MOOC (global leaning), because I see the devices and would like to work with devices but yes it takes time for me to implement, and to be clear to the point I explain them based on practical methodologies like how to make necessary connections, current calculation, parameter measurements and synthesis. A teacher should always be dynamic must poses interdisciplinary skills to share knowledge with different levels of students.

The course which I teach is Electrical Installation and Estimation which is highly practical oriented course which requires high understanding and problem solving skills to make this course interactive and engaging, I prepare some prototypes (devices) and take it to class room and display its working/principle functionalities to all different levels of students. I continuously adapt new teaching methodologies to felicitate lecture which becomes highly engaging with students they ask various questions. After taking the course, I have implemented many ways of learning and teaching styles. Each student has its own way of learning but what I believe and have observed is that.

"They listen-they forget,

They do-they understand,

They implement-they remember".

Foremost thing what exactly we are teaching and what are the objectives of the concerned course that matters the most. At the end of the course what students ability is did they possess clear understanding of the topics, did they implemented any prototypes etc. There are different courses each course has its unique identity some contains theoretical, practical, problematic, application oriented.

In the reading there are various model show cased that improves the quality of teaching and learning style to be used when felicitating a lecture to the different levels of learning styles (different levels of students). The models which are reflective in the paper are

1. Jung-Myers-Briggs model

2. Learning style model

3. Teaching style model

4. Kolb's model

As mentioned in the reading there are different types of learning styles and each learning style are sub divided into two types (**Table 2**).

Each learning style has advantage and disadvantage, if a student is a sensory learner then he is keen observant, more practical oriented, relies on fact/concrete data, does work in effective manner but this learner will not be able to perform well as compare

Perception		Input Modalities		Organization		Processing		Understanding	
Sensory	Intuitive	Visual	Auditory	Inductive	Deductive	Active	Reflective	Sequential	Global

Table 2.
Shows the different types of learning styles.

to intuitive learners they are fast but reckless, they grasp quick but no implementation etc. As per the R. Felder and L Silverman reading that each learning styles differs it also depends based on the ability and the type of exam they choose. In the organization based learning style there are two types inductive learning style is based on natural behavior of student but a deductive learning style reduces interest in learning in the field engineering. The major impacts of teacher on different learning styles are

1. Be organized: In one-hour session what teacher should do and how activity can be assigned so that each learning styles meets the required level of understanding (proper time management).

2. Pleasant: Always sound pleasant to students such that when they ask question they should not hesitate.

3. Sound knowledge: A teacher must pose technical and practical knowledge to address all the levels of students and to meet their pre-requisite standards.

4. Disciplined

5. Trustworthy

6. Honest

7. Sincere

8. Committed to teach: not by chance or choice; should have zeal and passion to teach all levels of learners.

9. Be present and available for students whenever they came to ask question or doubts

As per the R. Felder and L. Silverman, in engineering education there are students which have different learning abilities, different customs, rules/regulation but as a teacher we must follow new learning and teaching styles to address all the students effectively. As in a class room there are active learners or passive learners we should encourage all the students to majorly focus on objectives, content for the course which they are undertaking. As a teacher we need to be versatile, upto-date and dynamic since there are huge advancement in technologies day by day. This article was very helpful in finding ways of teaching by implementing new ways of learning in engineering education.

Technology plays an important role in making students more interactive, participative in classroom especially after the post lunch session where students feel drowsy in detail discussion on Technology enabled active learning is explained in [6]. As there is advancement in technology the demand of online learning courses increases over traditional class room courses. Due to flexibility in time, type of course, quality of education, completion of assignments etc.

The key aspects to remember in online courses over traditional class room courses are

1. Flexibility/Time management
2. Discipline
3. Blended education model
4. Social interaction
5. Organized lectures
6. Resources, materials and assignment on time

Online course requires dedication and interest to complete the course in a given amount of time. There are many misconceptions from student's side that by skipping classes they can complete the course, completing the assignment one day before or two days before the deadlines.

5. Key aspects for instructors in online courses

1. Focus on quality of education in online course
2. Design of online course material
3. Schedule of online course
4. Course planning/Lesson plan
5. Time management
6. Assessment
7. Evaluation/Rubrics
8. Quizzes
9. Attendance
10. Interactive (Poll questions, clearing doubts)

6. Problems faced by instructors in online courses

1. In large online classes clearing doubts in one-hour session becomes difficult for faculty and when it comes to assessing student performance of more than 90 students becomes very arduous.
2. Time management is important factor to discuss cognitive issues in online courses.

7. Advantages of taking online courses (students)

1. **Flexibility and Convenience:** Reading of modules is highly required but as per the flexible time for them to read and an easy way to join discussion.

2. Able to adapt different learning styles from the beginning

3. **Opportunities in Online Learning Courses/Career Advancement:** There are number of opportunities for students to learn as compared to traditional class room course where they can accumulate better knowledge and technical skills. It makes them an individual in the competitive world why? Because it develops students listening abilities, understanding (Reading skills) abilities, communication and making notes.

4. After going through an online course student will be able to develop own learning styles and self-learning abilities it also builds up confidence.

5. Sharing knowledge is highly encouraged in discussion forums among students and faculty which makes them to think in different learning levels.

6. For all different levels of students, it gives a clear platform to acquire required skills and knowledge by asking questions.

7. As most of the LMS or CMS is implemented and developed in US based education system which is highly resourceful and knowledgeable as expert faculties and advisors will be available to upgrade and enhance students learning also expert technical team will be available to tackle out the problems associated with E-Learning class room.

8. Online courses are organized in an effective way to provide quality education to students for upgrading their skills and knowledge.

8. Significant issues for students in online courses

1. **Due-dates**: As there is flexibility in choosing the course, there is also flexibility in reading modules and assignments as per students' needs but remember that due date will be mentioned for the particular assignment and discussions.

2. **Self-Motivation**: The students should be self-esteem; motivated to learn a distant education and must poses some technical literacy otherwise it is difficult.

3. **Number of online course availability**: Many online courses are available such as MOOC, UDEMY, YOUTUBE Videos, NPTEL lectures and notes, edX, Udaacity and many more but choosing and deciding right particular course to update skills and knowledge is an invariable challenge for students otherwise high cost.

4. **No face to face interaction**: in online courses hardly face to face interaction occurs between professors and students.

5. No social communication with classmates

6. **Adaptability to struggle at beginning of course**: When taking an online course, after going through all traditional class room course makes little difficult for students of traditional mind set for adopting to online classes, in short for students it takes time to get settled in online learning courses, Course Management System (CMS).

7. Limited time period to complete the course

8. **Technical Problems**: There are various technical issues comes around during online learning courses for students such as trouble shooting problems, good internet connectivity (for examples most of online courses requires more data and speed but due to lack of knowledge in computer and wifi connectivity students find problems to get registered into online courses even though for the present generation here the students are tech savvy but unable to create a proper word document to complete the assignment for a particular task.

9. **Computer Knowledge:** As mentioned above for the present generation students are tech savvy but due to lack of knowledge in soft skills in making documents, storing the data, and retrieving the data is a major problem for students.

10. **Time Management:** Here the ability to manage time is important because all the material and resources provided to them will not be discussed in online class most of learning comes from students only which makes them self-leaners and it helps students to develop their own technical skills and knowledge which can be applicable in real time application. Students must manage time to do their reading last minute reading makes their assignment and discussion quite confusing.

9. Strategies implemented

The concept of active learning comes out of interest of students and making lectures interactive but when we conducting an active learning environment for the first time in class room students find it difficult in the beginning but when they are accustomed to it becomes simple and energetic, during the first class activity were all students are new to each other we can use can activity called ICE Breaker. Active learning among students recuperates the quality of education and also improves students' performance in solving critical problems, retention of knowledge for longer period, motivation, confidence and better development in communication/interpersonal skills. It is a learner centered approach to teaching.

The major concerns in designing and implementing active learning in class are

1. Time management

2. Forming good groups/average groups

3. Organizing an activity with limited time period

4. For all different levels of students an active participation

5. Large size classroom

6. Material/complete handouts

7. Regularity/Punctuality of students

8. Disturbances (use of mobiles, ring tone, outside disturbance)

Strategies to overcome the major concerns (**Table 3**).
Course: Electrical Installation and Estimation.
Class Strength: 34.
Time: One hour.

Time Management	It is an important factor to any cause. In one hour session how to manage the lecture, topic and an activity. I have chosen a 15 minutes group activity for design of circuit and to do basic calculations. What I have found is some students have completed the task in 8 minutes and remaining seven minutes for them got wasted. For other groups they took entire 15 minutes to complete the task but some groups not even completed.
Forming good groups/ average groups	To know the level of understanding of each student I have conducted a pre-test to check everyone's knowledge depending on that I have formed groups.
Organizing an activity with limited time period	As said time is a major issue every second counts. We need to make sure that students get engaged in the task and try out new ways to solve critical problems even though the solution is not correct but trying is worth more than enough during this session.
Active Participation	It is very important that every student participate in activity choose an activity which catches students attention if its difficult problem they will hesitate to do it. If the activity is short and simple for them to design then students can ask more question related to that topic. The activity which I have chosen was JIGSAW, Think-pair-share and one minute paper writing.
Large size classroom	Not all the question of students will be covered in the activity but I have suggested students to pen down their question on a paper and submit to me so that the very next day I can able to answer all questions. I am presently using CANVAS for this task where students have asked me questions about their topics frequently. This becomes quite simple to answer all their queries in small amount of time. If the questions posted by students are thoughtful in that particular case I will discuss in class with all.
Material/handouts	Basically students like spoon feeding, the more we feed them the more they crave for. In this area I have encouraged my students to make their own notes or do self-study by providing them with necessary links and materials. If the situation is very worse (average or weak students) then I personally provide them with proper material/handout to understand the subject and should be able to apply in real time application. This happened with me where I have provided students with proper material and they really have implemented their micro, mini and major projects which are highly applicable for any application.
Regularity and Punctuality	Students can learn only if they are regular and punctual to their lectures. As the activity or the topic which we teach is thoughtful then the students will be regular/punctual. We should not repeat the same activity day by day as students feel that the teacher knows the area only apart from it does not know. Sometimes we must engage in learning with them and at times students really find some interest in attending classes/lectures.
Disturbance	Now days as there is huge demand of technology if we bring into classroom it causes disturbance in teaching and for other learners. In my previous experience students are allowed to bring the mobile phones with them for every 5 to 10 minutes a ring will be there which causes huge disturbance for me and to the learners. But in my present experience here students deposit they mobile phone in college cellar and there is no such cause of disturbance.

Table 3.
Shows the activities performed on various parameters.

9.1 Strategy to be adopted in classroom to enhance learning

a. **Research based methods:** Students prefer a variety of active learning methods when they are not interested in something, their attention quickly shifts elsewhere. Interestingly many of the components of their ideal learning environment less lecture use of multimedia, collaborating with peers are some of the techniques to be adopted.

b. **Relevance:** The role as a teaching is to shift the methodology from dissemination of information to application of information. The connection of course content to the current culture and happening is most important.

c. **Rationale:** There are variety of students, one of them are millennials who are more pampered by the parents and they are not readily accept the chain of command. A culture of sharing, caring, nurturing is important to deal with the millennials.

d. **Relaxed:** These days students prefer informal learning environment and informal interaction with the faculty inside and out of the classroom helps the students to develop the confidence on the faculty who is being taught and thus develops the respect on the subject.

e. **Rapport:** The students are extremely relational they are more attached with the friends rather than parents. Hence, collaborative learning, team projects, group assignments etc., helps them to learn more.

f. **Developing teaching modalities:** More usage of smart boards, audio clips just like play way method, teaching through management games are useful to attract various types of learners [3] and to stimulate the cognitive level.

g. **Materials related to learning:** Case study methodology helps the students to understand the learning and encouraging the students to present the ideas through point of discussion.

h. **Collaborative Learning:** Encouraging the open up of a dialog with the students and letting the students to develop the curiosity and explore the new things is a part of brain based learning.

Another strategy, I conducted in classroom Active Learning with concerns & strategies adopted Technology tool as Smart board, Mobile Phone Ring tone to commence & complete the activity:

Concern-1: I got ready and prepared with one topic and due to active learning technique, lost control over the topic and I ended up in teaching other content which wasted time.

Strategy: I should concentrate on the topic and should know where to stop if the content is getting diverted. As I cannot resist the students from learning, I can give the topic for home assignment.

Concern-2: Actually I took 20 minutes' time to explain the topic Electrical Machine: Synchronous Generators but due to the activities it was extended to 50 minutes.

Strategy: I should blend the course delivery according to the time schedule provided by university and plan according to maintain relevance of activities for students. I should be able to spend some good time to planning and designing the course delivery.

Concern-3: In group activities, some students were not involved completely. I found minimal involvement of some students.

Strategy: As my class strength was of 60 students, I divided the students into ten groups each of size 6. I found that for some of the activities one or two persons is enough to address the issue other four/five students were just observing. So I need to take care in designing the questions for group activities so that every student is having solid work to think and engage. In case of smaller activities, I will design tasks for individuals even though they are working in groups.

Concern-4: Some students are feeling that I am not taking enough responsibility in teaching the content and they are feeling burden to learn themselves.

Strategy: Since childhood days, they are trained and brought up in the same old traditional method. It is then better to start which small topics rather than going extensively as they need time to adjust to the changing system.

Concern-5: I am also in learning stage in adopting this system.

Strategy: Implementing such activities is quite interesting for me but I need to spend lot of time in knowing the techniques available in active learning. The interesting part in this activity is that I am learning a lot from my students.

9.2 Results and evidences of canvas implementation

Technology and Engineering Education is the use of accumulated knowledge to process resources to meet human needs to improve the quality of life. Students develop the ability to select and correctly use course materials, modern tools, techniques and processes to answer questions, understand explanations and solve problems encountered in real life applications in mini/major projects. These overriding themes require students to design, research, create, use, evaluate and modify systems of Electronics, Electrical, Biotechnologies, Information Technologies, Cyber Technologies and Physical Technologies [7] (**Figures 1–15**).

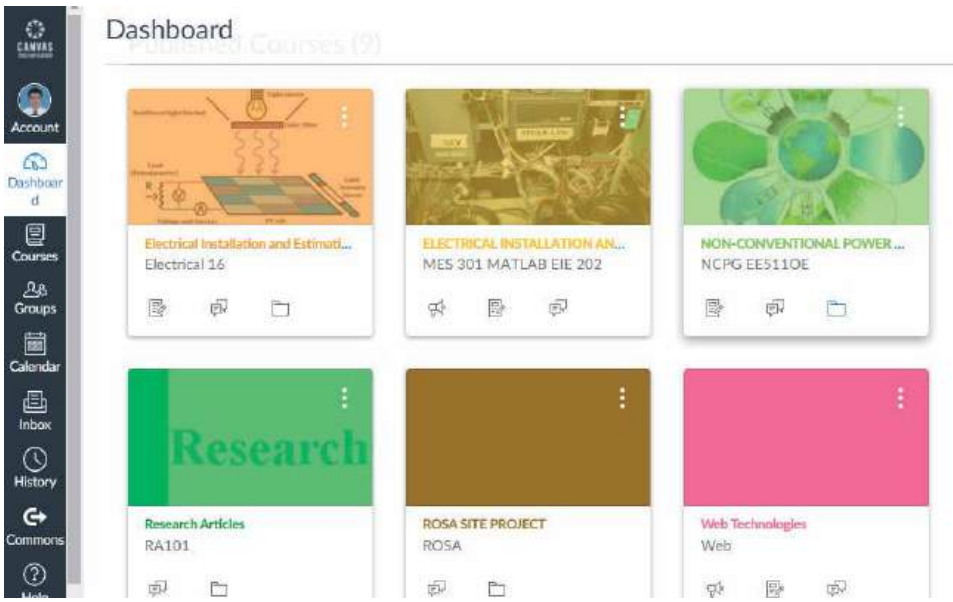


Figure 1.
Shows the dashboard of LMS which includes various courses.

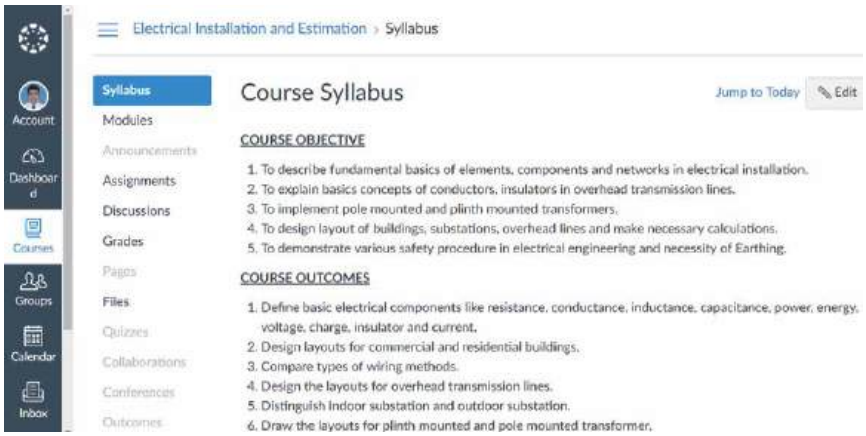


Figure 2.
Shows the syllabus of EIE course.

Figure 3.
Shows the notes uploaded for students reference and learning.

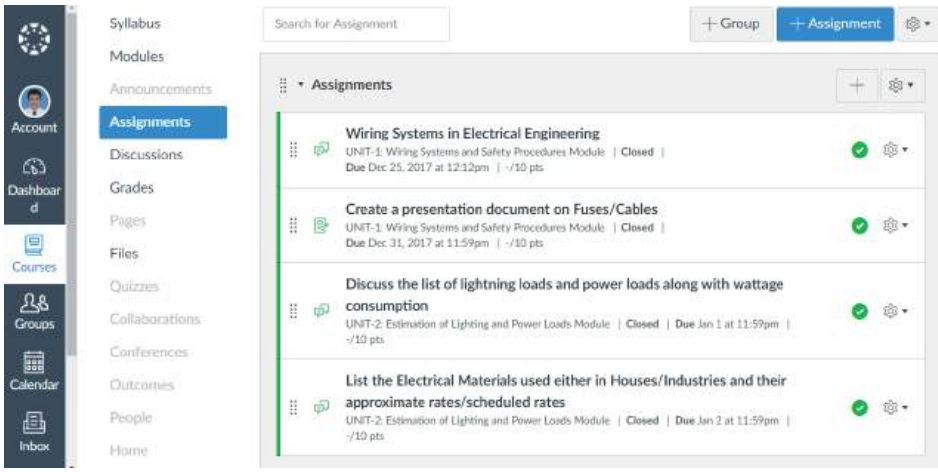


Figure 4.
Shows the assignments/discussion given to students.

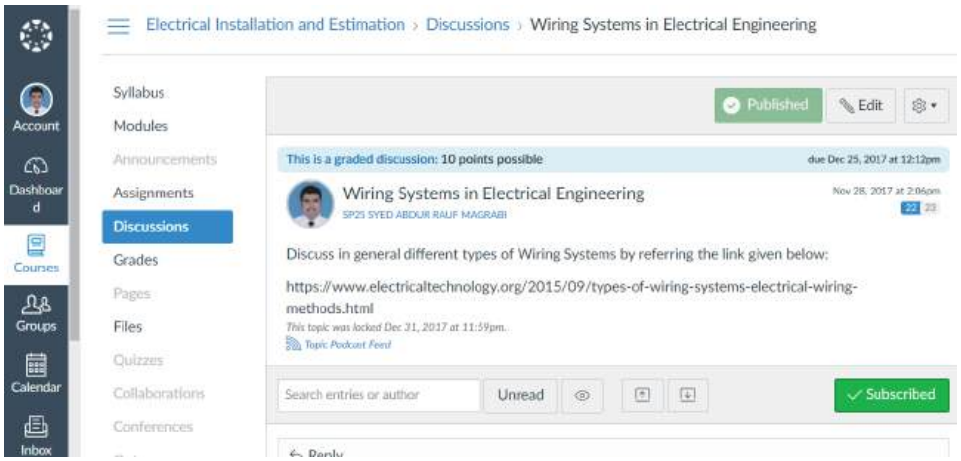


Figure 5.
Shows the discussion question for 10 points.

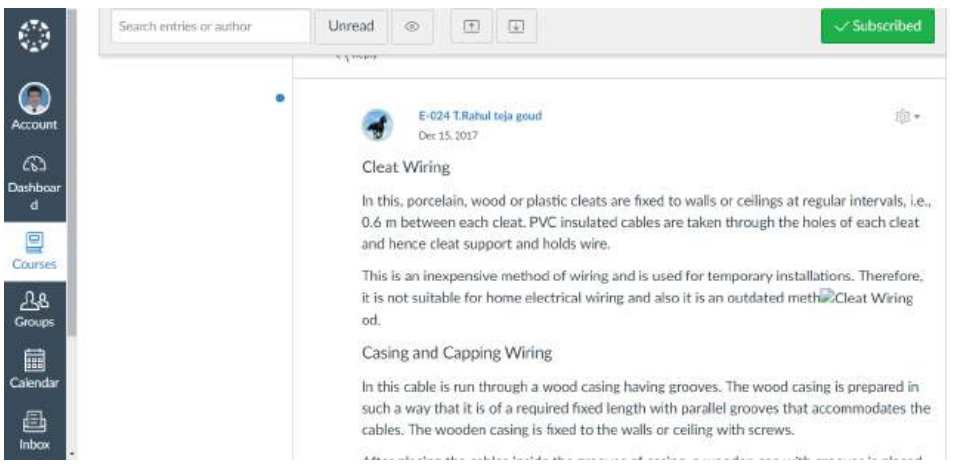


Figure 6.
Shows the students response for the given question.

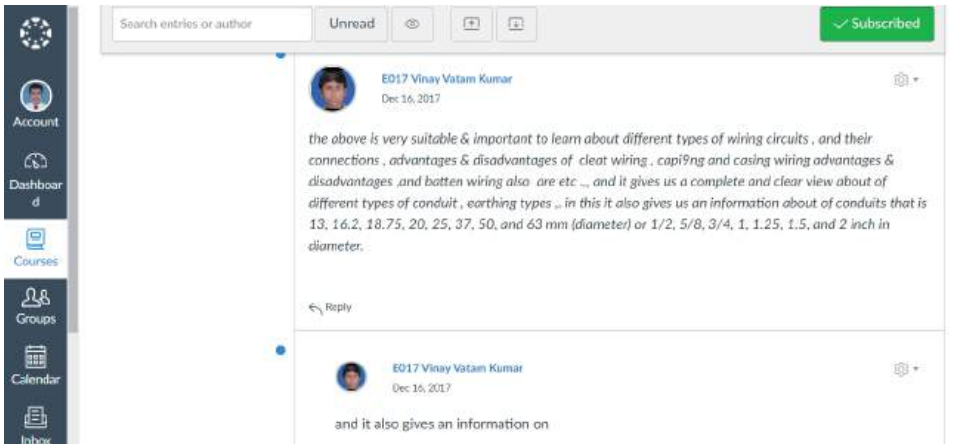


Figure 7.
Shows another student response for the given question.

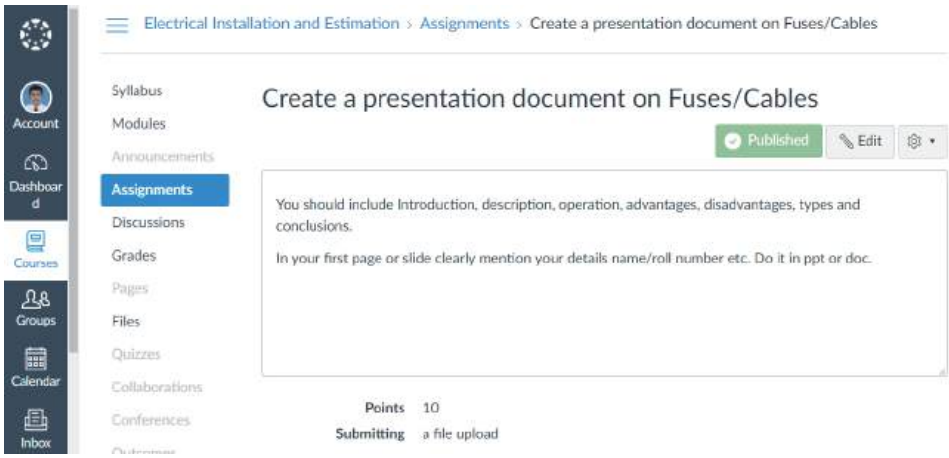


Figure 8.
Shows the assignment task.

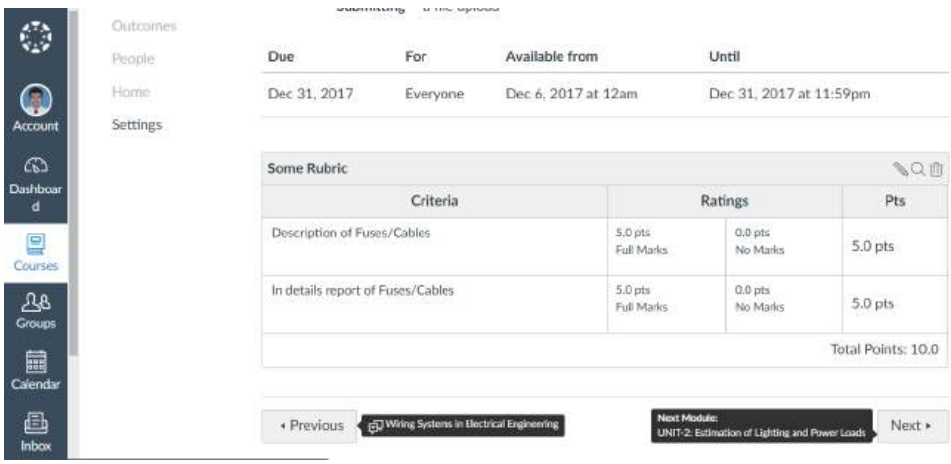


Figure 9.
Shows the assessment tool used rubrics.

Figure 10.
Shows evaluating students' performance using speed grader system.

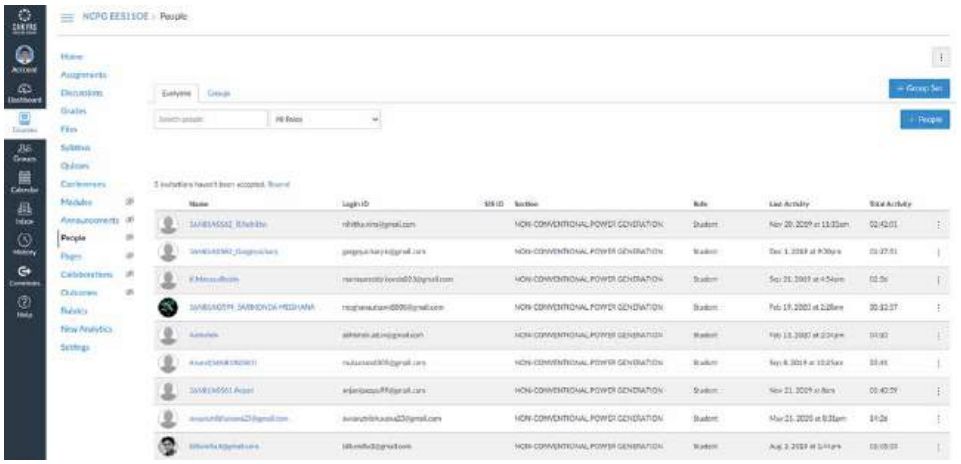


Figure 11.
Shows the attendance list of students and their activity details when using canvas (2019).

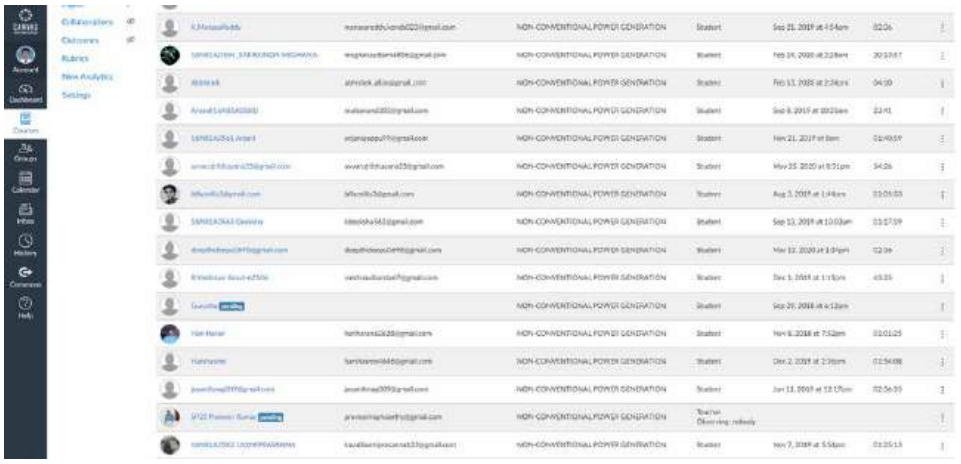


Figure 12.
Shows the total strength of students list when available online & date.

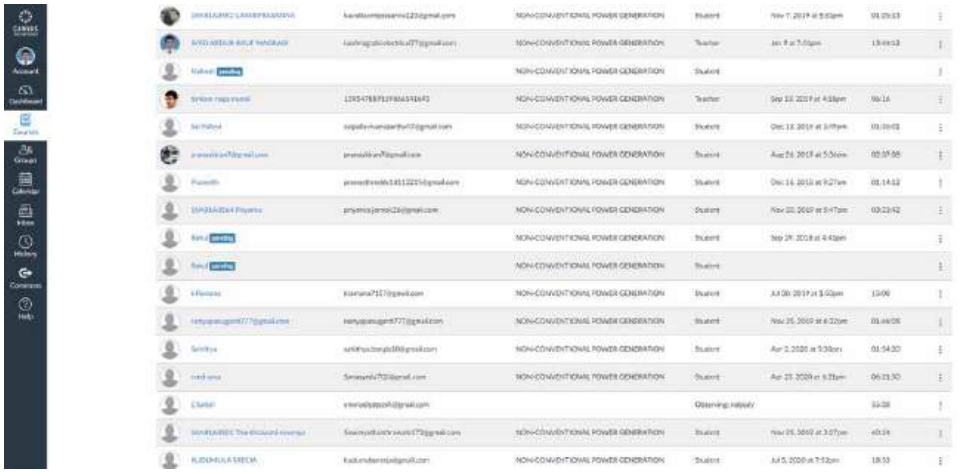


Figure 13.
Shows the attendance list of students & faculty and their activity details when using canvas (2019).

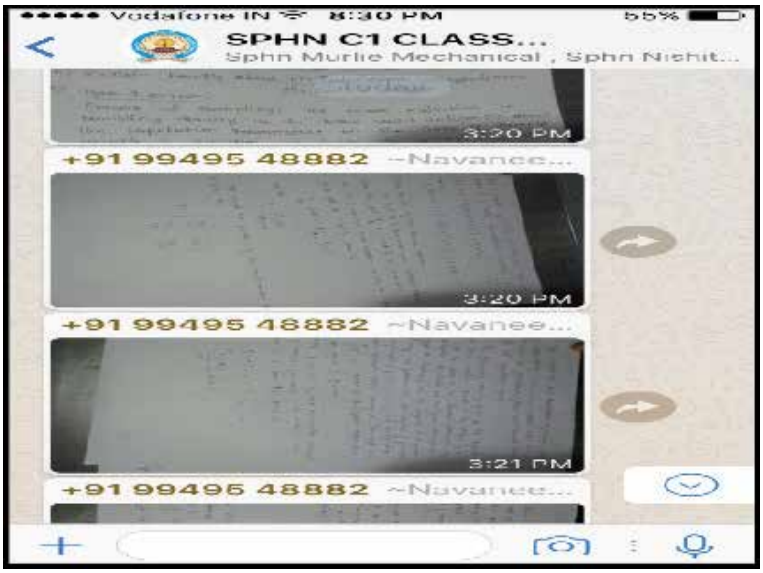


Figure 14.
Shows the use of technology through Whatsapp54 6 for transferring the information on EEE course.

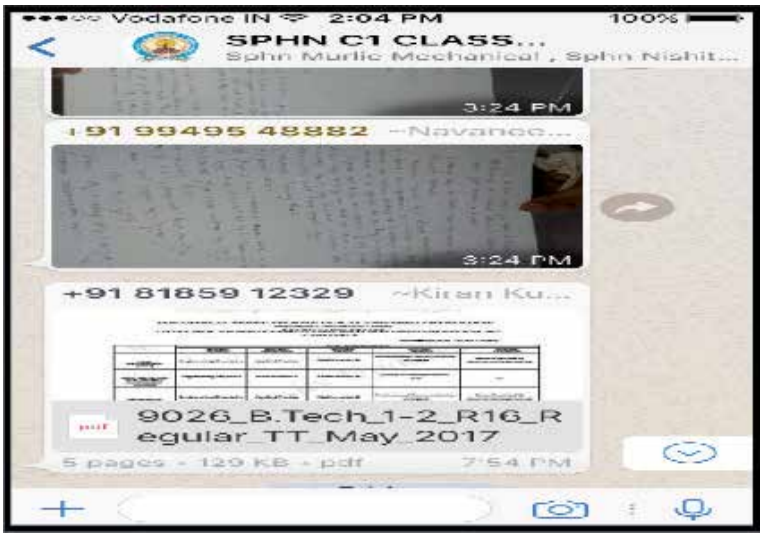


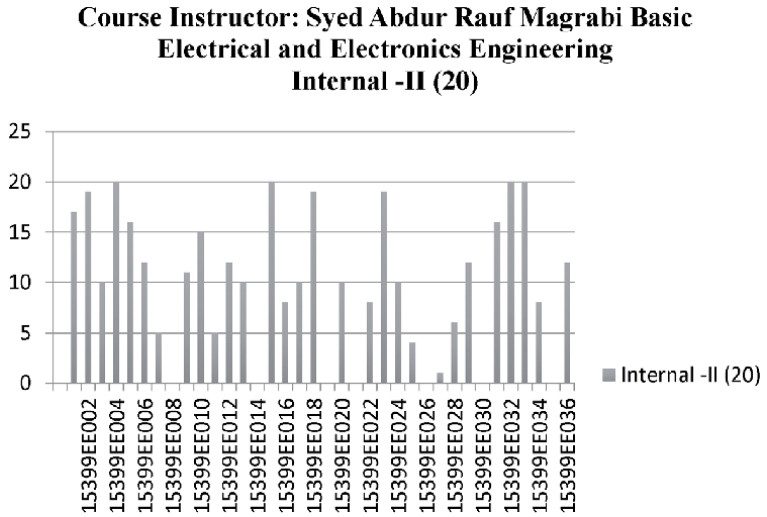
Figure 15.
Shows the use of technology mentioned here is the four-year duration of course of syllabus (2017–2021) batch.

10. Conclusion and results

There are advantages and disadvantages of active learning in class room some students learn but some do not but I as a teacher it's my responsibility to make them learn and concentrate in class. Active learning boosts the confidence of students and their involvement towards the subject.

Hence by implementing the above strategies student's confidence has improved they discuss their ideas and thoughts without any hesitation. There were some difficulties in managing classroom due to sudden change of teaching from traditional method to active learning methodologies in the initial classes but later with more organized manner I was able to implement good strategies in classroom such

as Think Pair Share, Write Pair Share, Collaborative learning, JIGSAW etc. and many more. Below statistical representation of data is shown and improvement of students leaning through active learning techniques [8] (**Tables 4** and **5**).



The major goal for engineering educators who want to instill critical thinking skills in their classrooms is to think of their students not as receivers of information, but as users of information. Learning environments that actively engage students in the investigation of information and the application of knowledge will promote students' critical thinking skills. In engineering education any skill, critical thinking requires training, practice, and patience. Students may initially resist instructional

Course Instructor	**SYED ABDUR RAUF MAGRABI**			
Couse Title	**Basic Electrical and Electronics Engineering**			
Classification of Students	**Advanced Learners**	**Slow Learners**	**Absentees**	**Total Students**
No. of Students	11	18	7	36
Percentage (%)	8.33%	80.55%	11.11%	100%

Table 4.
Shows the performance of students.

Aspect	**Excellent**	**Very Good**	**Fairly Good**	**Unsatisfactorily**
Deepening the understanding of the concept	✔	—	—	—
Promoting motivation to learn more about the concept/subject	—	✔	—	—
Encouraging class participation	✔	—	—	—
Building confidence	✔			
Contributing to the joy of learning	—	✔	—	—

Table 5.
Shows the feedback obtained from students upon the conduction of activity based learning.

questioning techniques if they previously have been required only to remember information and not think about what they know. They may struggle with assessment questions that are not taken precise from the book. However, by encouraging students throughout the process and modeling thinking behaviors, students' critical thinking skills can improve [5]. The reasons for allowing new teaching & learning techniques in classroom is to enhance the ideology of students to learn new things and to develop a real time project to tackle day-to-day life challenges, engaging in group learning activities helps the students to communicate with their peers without any hesitation. The learning outcomes for any engineering subject allows them to think and to do self-learning where teacher acts as facilitator and students a learner.

11. Students feedback

The above activity through technology based learning was implemented for diploma EEE second year students in Electrical Installation and Estimation and for B.Tech CSE Third year students on Non-conventional Energy resource, has a common topic on Safety procedures in electrical power engineering (**Table 6**).

At the end of the conclusions the following issues the students face when using technology and solutions as per student's feedback being provided below:

11.1 Issues of students

- Limited social interaction
- There is a limited opportunity to interact face to face to professors and other peers.
- Difficulty to develop relationships with classmates.
- Possibility of limited local networking opportunities.
- Most of the communication through e-mail, chat room of discussion groups, but no office to get together.
- No campus atmosphere to create social interaction.
- Computer boot-up time, software, connection to internet student may be required to learn computer trouble shooting skills.
- Addition cost of high speed internet.

S.No.	Questions	Poor	Fair	Good	Excellent
1.	Clear to understand the course content	0%	10%	20%	20%
2.	Discussions/materials posted was useful	0%	15%	10%	15%
3.	Would you recommend this course to friends	0%	12%	24%	14%
4.	Have you enjoyed online learning through technology based	5%	10%	15%	10%
5.	How far the topic was relevant	4%	20%	20%	6%

Table 6.
Shows the feedback obtained from students on electrical & electronics engineering course.

- Planning and adjust the studying schedule around instructor's assignment due date. If a student is scheduling to study in the nights, then he/she will have to wait for response from instructor.

11.2 Solutions to student's issues

- Students must have convenient access to the internet at home or through college, library and community computer.
- Students must know exactly what kind of technological support they need for certain course and properly equip themselves for the successful completion of assignments.
- To manage the assignments and course in an organized manner student need to develop proficiency in computer.
- Students must learn basic knowledge of computers, internet and typing.
- Students must have their own email accounts to access to a group conferencing program.
- Students must demonstrate the maturity to be responsible in the use of internet and own email accounts.
- Students must be self-motivated to get online and conduct their homework internet activities.
- Students and faculty can communicate through discussion forums, discussions can help group work among students and sharing the knowledge which leads to higher learning outcomes.

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Chapter 8

University Mathematics-Laden Education, Competencies and the Fighting of Syllabusitis

Tomas Højgaard

Abstract

Syllabusitis is a name for a disease that consists of identifying the mastering of a subject with proficiency related to a syllabus. In this chapter I argue that using a set of mathematical competencies as the hub of mathematics-laden education can be a means to fight syllabusitis. The introduction and thorough exemplification of this idea was the main outcome of the Danish KOM Project. Furthermore, a two-dimensional structuring of the relation between subject specific competencies and subject matter was suggested. As the analytic core of this chapter I argue that such a two-dimensional structure has proven to be a crucial element when attempting to put the competency idea into educational practice, and exemplify how that can be done when it comes to mathematics-laden education at university level.

Keywords: Competence, mathematical competencies, syllabusitis, university mathematics-laden education, two-dimensional content description

1. Introduction

Syllabusitis is the name of an educational disease. It consists of identifying the mastering of a subject with proficiency related to a syllabus [1–3]. This is a sometimes convenient, but severely damaging reduction of complexity, among other things because it defocuses the teaching and learning of the subject. Everyone with a sense of mastering a subject will agree that there is much more to it than proficiency related to a syllabus, and this 'much more' is forgotten (or neglected) in a system infected by syllabusitis.

My impression is that syllabusitis is widely disseminated in mathematics education systems around the world. My intention here is not to defend the validity of this impression, but to use it as a framing of a more constructive analysis initiated by the questions: How can we describe the content of mathematics-laden education in a way that supports the fight against syllabusitis? In particular: How can such a description become a source of inspiration for teachers' work and professional development?

The first question was one of the dominating points of departure for the Danish KOM Project, whose basic approach to the question of mathematical mastery I lay out in the next section, cf. Højgaard [4] of which the following sections of this chapter is an edited version. In section three, I address the second question by arguing that a two-dimensional structure has proven to be a crucial element when

attempting to put the competency idea into educational practice, and in section four I present a specific example: using the two-dimensional structure to challenge and focus the planning of mathematics-laden education at university level. In section five, I finish by discussing some general perspectives for future curriculum development.

2. Mathematical competencies as 'guiding stars'

2.1 Syllabusitis and curriculum structure

In many countries, Denmark being one of them, the traditional way of specifying a mathematics curriculum is structured around the following components (cf. [5]):

- The *purpose* of the teaching.
- A *syllabus*, i.e. an outline of the topics (concepts, procedures, results etc.) to be covered.
- The instruments of *assessment and testing*.

Sometimes the purpose is determined first and used as a basis for the establishment of the syllabus and the modes of assessment and testing. Often, though, the syllabus is determined first and the purpose added as a sort of politically oriented foreword, the modes of assessment and testing only referring to the syllabus-specific goals and the formal settings ('A four-hour written test' etc.). The establishment of the syllabus becomes the hub of curriculum development and, consequently, the central arena for discussions between the teachers, the recipient bodies and institutions and the curriculum developers.

In such a system, syllabusitis is systematically fertilised, not only at the system level of curriculum development, but also – and this is the core of the problem – in the minds and practices of mathematics teachers. To my experience, it is a generally accepted claim that the main channel of communication between 'the system' and the mathematics teachers regarding the content and orientation of the teaching is a list of guiding tasks for the written exam. If this list is structured mainly as an attempt to cover the syllabus, because it is constructed by people who are in the heart of a system infected by syllabusitis, then it should be no surprise that the minds and practices of the teachers are formatted in the same way.

2.2 Mathematical competencies as 'the missing link'

One of the causes for the syllabus-focused curriculum structure is that we have nothing else to turn to when searching for a structure that is well suited for communication between the different bodies involved in mathematics-laden education. The purpose of the teaching, being the natural alternative, is a much more general kind of statement with no direct relation to the planning and orchestration of the teaching. This creates a 'missing link' between the purpose and planning of a structure for classroom activities, and only a minority of the teachers are able to create this link themselves.

This problem was one of the reasons for the initiation of the Danish KOM Project ('Kompetencer Og Matematiklæring', Danish for 'Competencies and

Mathematical Learning'), which took place in the years 2000–2002 (cf. [5–7]) and was directed by Mogens Niss for whom I acted as academic secretary. Based on previous work by Niss [8] the important analytical steps carried out in this project were (cf. [9]) to:

- move from a general understanding of the concept *competence*, which I – in semantic accordance with the KOM Project – take to be someone's insightful readiness to act in response to the challenges of a given situation [1],

- to a focus on *a mathematical competency* defined as someone's insightful readiness to act in response to a certain kind of mathematical challenge in a given situation (ibid.),

- and then identify, explicitly formulate and exemplify *a set of mathematical competencies* that can be agreed upon as independent dimensions in the spanning of what it means to master mathematics, cf. **Figure 1**.

In short, these competencies can be described as someone's insightful readiness to …

Mathematical thinking competency: … carry out and have a critical attitude towards mathematical thinking.

Problem tackling competency: … formulate and solve both pure and applied mathematical problems and have a critical attitude towards such activities.

Modelling competency: … carry out and have a critical attitude towards all parts of a mathematical modelling process.

Reasoning competency: … carry out and have a critical attitude towards mathematical reasoning, comprising mathematical proofs.

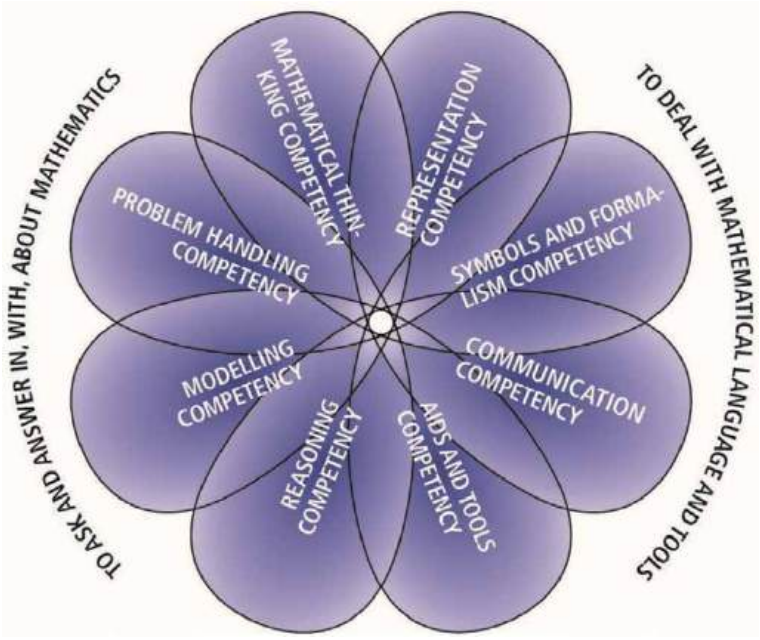

Figure 1.
A visual representation of the eight mathematical competencies presented and exemplified in the KOM report [7].

Representing competency: ... use and have a critical attitude towards different representations of mathematical objects, phenomena, problems or situations.

Symbol and formalism competency: ... use and have a critical attitude towards mathematical symbols and formal systems.

Communicating competency: ... communicate about mathematical matters and have a critical attitude towards such activities.

Aids and tools competency: ... use relevant aids and tools as part of mathematical activities and have a critical attitude towards the possibilities and limitations of such use.

Such a set of mathematical competencies has the potential to replace the syllabus as the hub of the development of mathematics-laden education, because it offers a vocabulary for a focused discussion of the aims of mathematics education that can make us feel comfortable for the same reasons that we are comfortable with the traditional specificity of the syllabus [1].

3. A two-dimensional structure for the content of math education

The work with mathematical competencies laid out in the KOM report is one of many attempts to generate a more broad and ambitious framing of the design of mathematics-laden curricula, where 'something more' than just mere syllabus reproduction is expected. The most well-known example is probably the American "Principles and Standards for School Mathematics" [10, 11], but many other countries have been through similar developmental processes during the last two to three decades.

For me an interesting experience was when I had the opportunity during a sabbatical leave in 2009 to get acquainted with a by then ongoing process of developing a new national curriculum for general education in Australia, including a new framework for mathematics education ([Australian] [12]). The main feature of this framework is to distinguish between content strands, which I read as parallel to a syllabus, and proficiency strands, which I (cf. [13]) read as the chosen approach to fill out the 'something more' part of the curriculum. In the short version, the approach chosen in the Australian framework is described as follows:

> *The content strands describe the 'what' that is to be taught and learnt while the proficiency strands describe the 'how' of the way content is explored or developed i.e. the thinking and doing of mathematics. Each of the 'content descriptions' in the mathematics curriculum will include terms related to understanding, fluency, problem solving or reasoning. ([Australian] [12], p. 7)*

Since the whole quote is emphasized is an unusually clearly stated example of what I based on unsystematic experience believe to be a very common way to relate the syllabus and the 'something more' part of a curriculum. It can be described as supplementing the syllabus with specific subject-related goals ('acquire computational fluency with ...', 'develop a general understanding of ...' etc.), and is also used in the American Standards mentioned above.

The problem with this 'syllabus with comments' approach depicted in **Figure 2** is that it does not once and for all fundamentally depart from the tradition of writing up the content of mathematics education in a linear fashion, it just 'dresses it up' with some new ambitions. Hence, it is still possible to forget or neglect the new ambitions of the curriculum and carry out the much to easy transformation of the linearly described content into a by nature also linear plan for the teaching of the content: 'Algebra' as the heading for part one of the plan, 'Geometry' as the heading for part two, etc.

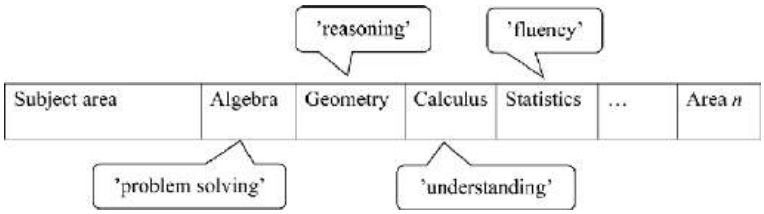

Figure 2.
A 'syllabus with comments' structuring of the content of mathematics education.

Subject area / Competency	Algebra	Geometry	Calculus	Statistics	…	Area *n*
Math. think. comp.						
Probl. handl. comp.						
Modelling comp.						
Reasoning comp.						
Representation comp.						
Symbols & form. comp.						
Communication comp.						
Aids and tools comp.						

Figure 3.
A two-dimensional structuring of the content of mathematics education (adapted from [7]).

In the KOM Project we suggested the alternative of using a matrix structure for incorporating mathematical competencies in mathematics curricula [7]. **Figure 3** is an adapted version of this model with the combinatorial cell structure left out. One of the consequences of this approach is that it makes didactical considerations necessary when planning from a two-dimensional content structure to a timewise one-dimensional teaching plan.

4. Using the two-dimensional structure – an example from university level

In the last decade or so, the two-dimensional structuring of content suggested here has been used for various curriculum developments in Denmark from primary school to university (cf. [5]). In this chapter I will exemplify how that can be approached at university level, based on the elaborated presentation in Højgaard & Jankvist [14].

The School of Education at Aarhus University in Denmark offers a master's programme in mathematics education, parallel to several other educational master's programmes (cf. [15]). I have been the person responsible for that programme since its latest major educational re-design in 2005, of which I was the main architect. That process took place only a few years after the intense work with the KOM Project, so it is of little surprise that the educational design is not least framed by a competency approach to mathematics education. There is, however, also a more substantial reason for this choice made by my colleagues and I in the mathematics education group at Aarhus University: We acknowledge the fundamental challenge of fighting syllabusitis in mathematics-laden education across educational levels, and we agree that a set of mathematical competencies is a useful developmental tool to address this challenge.

Hence, we have chosen to use the framework of mathematical competencies as a basis for the design of the mathematically focused part of the master's programme.

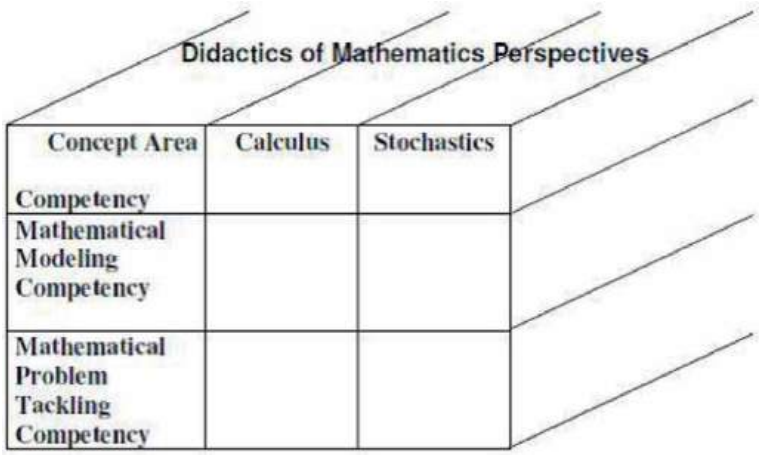

Figure 4.
A visualization of the content of the educational module: 'Mathematics in a Didactical Perspective I' ([14], p. 87).

That part covers two compulsory course modules; *Mathematics in a Didactical Perspective I and II* (cf. [15]). For each of these modules two mathematical competencies and concepts from two mathematical subject matter areas have been chosen as the two-dimensional mathematical content. To maintain a focus on mathematics education in the entire master's programme, this content is put into a didactical perspective, giving us a three-dimensional content model for each of the two modules, of which the first is visualized in **Figure 4** (cf. [16], which on request can be emailed).

5. Discussion

The generalizability of this model can and should be tested and challenged. To make a long story short, my experience from participating in several research and development projects framed by a two-dimensional mathematical content description is twofold (cf. [14]):

a. One of the main advantages of using a two-dimensionally structured competency perspective on mathematics-laden education is that it inherently fosters reflections among the teachers involved about the foci of the different mathematical competencies involved in the two-dimensional content structure [9].

b. Such reflections promote the more ambitious kind of work processes aimed at in mathematics-laden education, if the teachers involved get the necessary time and support (as was the case with the example given above) to learn how to use the two-dimensional structure as a developmental tool (cf. [17]).

As for the third dimension of the model in **Figure 4**, it has proven both important and helpful for my colleagues and I when communicating with each other and with the students about the focus of the different modules. The didactics of mathematics perspective reminds us all that this is the context in which the mathematical content should be taught, learned and assessed, and I see no reason why that could not be replaced with "engineering perspective", "biology perspective", etc., to form a useful developmental tool in other educational settings.

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Chapter 9

The Development Biology Authentic Learning of Mahasarakham University Demonstration School (Secondary), Thailand

Wutthisak Bunnaen

Abstract

This chapter presents the "Development of Authentic Biology Learning Activities, Mahasarakham University Demonstration School (Secondary)" research study. The study included a sample group of 160 students in Grade 10 at Mahasarakham University (MSU) Demonstration School (Secondary), Thailand, divided via purposive sampling into an experimental group of 80 students and a control group of 80 students. The experimental group used authentic learning techniques to study biology, whereas the control group used normal learning to study the same subject. The study used a quasi-experimental design to assess biology knowledge after learning in both groups as well as the experimental group's attitude towards the active learning method. The instruments used include a set of authentic biology learning activities, biology knowledge tests, and an attitude questionnaire. Results show that students in the experimental group increased their knowledge of biology after engaging in authentic learning and had a positive attitude about learning via this method. Authentic learning activities in biology give students a better understanding of the subject, evidenced by higher knowledge test scores after authentic learning, and thus is an effective way to organize learning activities for students not only in biology but in other courses of study as well.

Keywords: authentic learning, biology, learning activities

1. Introduction

The Basic Education Core Curriculum in Thailand consists of eight core subjects: Thai language, mathematics, science, social studies, religion and culture, health and physical education, arts, careers and technology, and foreign languages. It is based on the belief that everyone can learn and develop themselves to their full potential. The Mahasarakham University (MSU) Demonstration School (Secondary) emphasizes the development of learners according to their aptitude and potential to study in higher education and in their future careers. This development creates a positive attitude towards the use of innovative information system technology and promotes the use of scientific processes. The learning activities employed at the school are able

to draw out the potential of learners according to their interests and aptitudes, cultivate virtue and ethics, and transfer cultural identity to international standards. A society that seeks knowledge of the truth cannot deny that research is a vital tool in finding answers. Understanding human behavior through teaching and learning is necessary to apply research to improve the quality of teaching and to use research results to solve problems and develop a sustainable society. The concept of teaching and learning research is therefore emphasized. Teaching and learning improvement bring innovative teaching and learning to classrooms and schools [1]. Many students in Thailand have not attained the expected foundational skills in education, as evidenced by the results of national examinations and international assessments [2]. Drop-out rates remain high at the secondary school level, which leaves too many young people exposed to the harsh realities of the labor market without the necessary skills to thrive [3]. Education is an important factor in developing people to have the qualifications society needs. Therefore, education must try to be consistent with complex and rapid social changes. A student-centered approach is one of the highest priority projects and one aimed at elevating student achievement, helping students develop twenty-first-century skills, and encouraging students to be good Thai citizens with morals and ethics. Furthermore, area-based educational reform guidelines, such as educational institutes, educational service areas, local government, and the provincial administration, can be considered important targets in terms of operations and must be consistent with the context of the area with limited time and budget. To assess achievement, the Office of the Basic Education Commission (OBEC), Thailand, which is responsible for promoting and managing basic education in the country, proposed new teaching and support methods including mentoring, coaching, and peer coaching. Active learning has received increased attention in the past several years; it has been a popular concept in Thailand for the last few decades. According to the vision of education policy in Thailand, the objectives are to develop a learning society by focusing on increasing educational opportunities and promoting active learning behavior in students. The main shift in learning is a change in focus from the teacher to delivering active learning to engage students with the material. Students are therefore actively involved while listening to formal presentations in the classroom. Most importantly, to be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation [4, 5].

Authentic learning is a form of learning innovation. It is a learning style that encourages students to create useful and tangible products to share with the world. Once educators provide the motivational challenge, they develop and provide the necessary criteria, planning, timing, resources, and support to boost student success. Teachers become guides or event managers. The facilitator is not a dictator.

Therefore, in the development of teaching and learning, focus is on students' learning potential. As a learner in the twenty-first century, it is essential that the MSU Demonstration School (Secondary) is responsible for teaching and learning at the basic educational level to develop a learning management model that gives learners the potential and skills they need for living and self-development at a higher level. Learning activities should emphasize connecting with real life and applying knowledge to keep pace with changes in society and technology. Authentic learning activities that highlight the importance of real-world learning can link knowledge with daily life and life skills development.

2. Objectives

1. To develop biology learning activities using authentic learning with Mathayomsuksa 4 students at the MSU Demonstration School (Secondary).

2. To compare knowledge scores in biology among students who learn via authentic learning with students who learn via normal activities.

3. To study the students' attitudes towards authentic learning before and after using the learning activity package.

3. Research hypotheses

1. Students who use the authentic learning method will have higher biology knowledge scores after studying than they had before studying.

2. Students who use the authentic learning method will have higher biology knowledge scores than students who use normal learning activities.

3. Students who use the authentic learning method will have a better attitude towards the method after using it.

4. Research methodology

4.1 Population and sample

4.1.1 Population

The study population included 280 Mathayomsuksa 4 Students in science and mathematics at the MSU Demonstration School (Secondary).

4.1.2 Sample group

The sample group included 160 students in Grade 10 divided via purposive sampling into an experimental group of 80 students and a control group of 80 students.

We employed a quasi-experimental design as follows:

$$(O_1 - X - O_2)$$
$$(O_1 - C - O_2)$$

where O_1 is the pre-test (Pretest); X is the use of innovation (Treatment); C is the control group; O_2 is the posttest and qualitative research based on descriptions, observations, and interviews with teachers and effective learning activities.

4.2 Research tools

1. Authentic Learning Biology Activity Kit.

2. Biology Knowledge Test.

3. Authentic Learning Attitude Questionnaire.

4.3 Construction and qualification of research tools

The construction of research tools proceeded according to the following steps:

4.3.1 Building and Finding Quality Authentic Learning Activity Kits

1. Design a set of authentic learning biology activities for Mathayomsuksa 4 science students.

2. Determine the validity of the learning activity set by having a specialist check for consistency of content using the following scoring criteria:

   Grade level + 1 when sure it's appropriate.

   Grade level 0 when unsure.

   Grade level − 1 when sure it is not suitable.

   Analyze the content-consistency index of the learning activity series using Index of Item-Objective Congruence (IOC). IOC values of 0.50 or greater were selected. Results from an expert content validation examination showed an average of 0.96, indicating that the content-content-based learning set was applicable.

3. Have an expert assess the suitability of the learning activity set using a five-level suitability rating scale as follows:

   5 = most suitable.

   4 = very appropriate.

   3 = moderately appropriate.

   2 = less suitable.

   1 = least appropriate.

   The experts' suitability assessment average score is used as the following points ([6], p. 100):

   4.51–5.0 = suitable.

   3.51–4.50 = very suitable.

   2.51–3.50 = moderately appropriate.

   1.51–2.50 = less appropriate.

   1.00–1.50 = least appropriate.

   If the expert opinion suitability mean is 3.51 or greater, the learning activity set is appropriate and can be used for evaluation results. The determined mean suitability of 4.91 is the most appropriate.

4.3.2 Building and searching for a quality Authentic Learning Attitude Questionnaire

1. Create an attitude test per authentic learning activities for Mathayomsuksa 4 science students.

2. Find straightness in the attitude measurement model by verifying content validity using the following scoring criteria:

   Grade level + 1 when sure it's appropriate.

   Grade level 1 when in doubt.

Grade level − 1 when sure it is not suitable.

Analyze the content-validity index of the attitude measurement form. Subjects with an IOC value of 0.50 or greater were selected. The results of an expert content validation examination showed an average of 0.96, indicating that the attitudes were content-based and could be used.

3. Have an expert assess the suitability of the learning activity set using a five-level suitability rating scale as follows:

   5 = most suitable.

   4 = very appropriate.

   3 = moderately appropriate.

   2 = less suitable.

   1 = least appropriate.

   The experts' suitability assessment average score is used as the following points ([6], p. 100):

   4.51–5.0 = suitable.

   3.51–4.50 = very suitable.

   2.51–3.50 = moderately appropriate.

   1.51–2.50 = less appropriate.

   1.00–1.50 = least appropriate.

   The mean of suitability was determined, that is, if the expert opinion average was 3.51 or higher, the attitude scale was considered appropriate and can be used. The suitability of experts found the mean of 4.80 to be the most appropriate.

4.3.3 Construction and Quality of Biology Literacy Test

1. Create a biology knowledge quiz of 40 questions, covering the content used in teaching.and Bloom's revised taxonomy.

2. Determine the test's validity via expert content validation (IOC) and by analyzing the test's content integrity index by choosing an item with an IOC value of 0.50 or greater.

5. Data analysis

1. Analyze the results of expert evaluation of the quality of tools.

2. Analyze the results of the knowledge test before and after authentic learning in the experimental group and before and after normal learning in the control group using mean, percentage, and standard deviation.

3. Analyze and compare the average results of the knowledge test in the experimental group before and after authentic learning using t-test.

4. Analyze and compare the average results of the knowledge test in the control group before and after normal learning using t-test.

5. Analyze and compare the mean results of the knowledge test in both the experimental and control groups using t-test.

6. Analyze the results of attitude measurement in the experimental group before and after authentic learning using mean, percentage, and standard deviation.

7. Analyze and describe data from observation and interviews with students and subject teachers.

The statistics used in the data analysis include mean, standard deviation, test results and hypotheses, and independent t-test.

6. Results

The Authentic Learning Biology Learning Activity Kit for Mathayomsuksa 4 students at the MSU Demonstration School (Secondary) emphasizes the use of actual operations in the learning environment. The learning activity set was sent to five experts to assess consistency and suitability. It was found that the learning set had an average suitability score of 0.96, which was higher than the specified criteria of 0.50. This means the content is relevant and applicable. Experts found the mean of 4.91 to be the most appropriate. **Tables 1–3** present the results of the study.

Students	Sample (n)	Total score (N)	Pretest			Posttest		
			Total	$\acute{x}$	S.D.	Total	$\acute{x}$	S.D.
Experimental group	80	40	717	8.96	1.73	1039	12.98	2.31
Control group	80	40	598	7.47	1.93	603	7.53	1.88

Table 1.
Results of biology knowledge test analysis in experimental and control groups before and after learning.

Item	Pretest (N = 40)		Posttest (N = 40)		*t*	P
	$\acute{x}$	S.D.	$\acute{x}$	S.D.		
Knowledge (n = 80)	8.96	1.73	12.98	2.31	−12.51	.000*

**Significant .05.*

Table 2.
Results of comparative analysis in experimental group before and after authentic learning using paired t*-test.*

Item	Pretest (N = 40)		Posttest (N = 40)		*t*	P
	$\acute{x}$	S.D.	$\acute{x}$	S.D.		
Knowledge (n = 80)	7.47	1.93	7.53	1.88	−.236	.814*

**Significant .05.*

Table 3.
Results of comparative analysis in control group before and after normal learning using paired t*-test.*

7. Results

Biology knowledge test analysis results show an average score of 8.96 in the experimental group prior to authentic learning and a score of 12.98 after authentic learning, whereas the control group had an average score of 7.47 before normal learning and a score of 7.53 after normal learning (**Table 1**).

Comparative analysis of the results shows a mean score of 8.96 in the experimental group prior to authentic learning and a score of 12.98 after authentic learning, with an average increase of .05 (**Table 2**). Results in the control group show negligible difference in scores among the control group either before or after normal learning (**Table 3**). Comparative analysis of the mean results of the biological knowledge test in both the experimental and control groups shows that students in the experimental group had higher scores on the biology knowledge test overall (statistically significant at the .05 level) compared to the control group (**Table 4**).

Attitude measurement results show an average score of 4.51 or greater for all survey questions in the experimental group, suggesting that students who used authentic learning had a positive attitude towards it.

Item	Pretest (N = 40)		Posttest (N = 40)		*t*	P
	$\acute{x}$	S.D.	$\acute{x}$	S.D.		
Knowledge (n = 80)	12.98	2.31	7.53	1.88	−16.31	.000*

**Significant .05.*

Table 4.
Comparative analysis of the mean results of the biological knowledge test in both the experimental and control groups.

8. Discussion

Authentic learning is a form of learning innovation in which the facilitator is not a dictator and students are allowed to make meaningful and useful in real life or simulated work. It gives learners the opportunity to connect directly to the real world. Our study shows that the Authentic Learning Biology Learning Activity Set had an average consistency value of 0.96, which is greater than the specified criteria of 0.50. This shows that the learning activity set is relevant to the content and can be used. Expert evaluation results found that the mean of 4.91 was the most appropriate, which is similar to results from a study by Noi-nont [7]. This study assessed learning in students and found that those students assessed using a simulation model had higher scores in every aspect including motivation for learning (statistically significant at the .05 level) compared to students in the normal assessment group.

Designing a biology laboratory around authentic learning methods that is suitable for the learner and uses real-world situations facilitates learning by having students participate in and work on real-world problems. It engages learners with practice exercises, role playing, case studies, and involvement in a virtual community of practice [8].

The results of this study show that students in the experimental group increased their biology knowledge scores from 8.96 to 12.98 after authentic learning. Students in the control group had an average score of 7.47 before normal learning and a score of 7.53 after normal learning. These results suggest that authentic learning activities give students a greater level of knowledge and understanding of the content. It is an effective way to organize learning activities for students that can be adapted and applied to other courses of study [9, 10].

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Edited by Olena Lutsenko and Gregory Lutsenko

In the context of globalization changes in educational systems, it is important to modify approaches to the educational process and introduce learning technologies that allow for maximum involvement in learning. One such technology is the technology of active learning, which engages learners through participation in the cognitive process and certain tasks as well as through the collective activities of the subjects of the educational process. This book discusses the theoretical analysis of active learning and contains practical recommendations for its implementation.

Published in London, UK

IntechOpen

ISBN 978-1-83968-478-4
9 781839 684784