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INTERDISCIPLINARITY AND TRANSDISCIPLINARITY IN TEACHER EDUCATION

Tatsiana Tsitavets (a)*
*Corresponding author

(a) Belarusian State Pedagogical University named after Maxim Tank, Minsk, Belarus, t_titovets@mail.ru,

Abstract

Human knowledge has become so complex nowadays that it outstrips human ability to accumulate it and increasingly complex world issues are beyond the capability of isolated disciplines to solve them. Education is under pressure to work out new ways to generate and transfer knowledge. The paper offers insights into the various strategies of compressing the learning content and codifying emerging data in education. Interdisciplinarity and transdisciplinarity in education are described as a strategy of curriculum modernization that successfully tackles information overload. Although researchers elaborate the conceptual connections between integration and evolutionary processes in education and propose different approaches to adapting ideas of interdisciplinarity and transdisciplinarity in higher education, there is still a paucity of literature on the practicalities of their implementation in teacher training programs. The paper innovates by uncovering the pathway for initiating interdisciplinarity and transdisciplinarity in teacher education. It presents methodology guidelines for transdisciplinary learning and a model for interdisciplinary curriculum as a sequence of teaching strategies which comply with students' cognitive progression. Although the model was developed from teacher education program it is jargon-free and can augment its appeal within other training programs. The paper concludes with an outlook on future work seeking to tap the potential of integrated curriculum in teacher training programs.

Keywords: Interdisciplinarity**,** transdisciplinarity**,** teacher education**,** curriculum design .

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1. Introduction

With increasing complexity of world problems and information overload the issue of curriculum integration in education gains special significance. In the digital society knowledge develops at an amazingly high pace and puts pressure on education to develop new training programs and methodology which could bring students up to date with latest discoveries in various fields of science. However, knowledge has become so complex nowadays that it outstrips human ability to accumulate it and therefore higher education institutions are forced to restructure the whole curriculum design and seek new ways to modernize the learning content and codify emerging data.

To tackle information overload education institutions developed four strategies of curriculum modernization: conceptualization of learning content, shift towards generic and lifelong learning skills, increasing specialization of training programs, and interdisciplinary (and transdisciplinary) curriculum integration. These strategies were defined by the author of the paper as a result of comprehensive study of curriculum design in teacher training institutions in the home country and abroad. Let's examine each of these strategies.

Conceptualization of learning content. Information today is so plentiful that any attempts to keep pace with ever-increasing data and incorporate it into the syllabus of academic disciplines are tantamount to fighting a losing battle. When learners are drowned in information they fail to assimilate it to the full extent. This is why it sounds as a good option for curriculum designers to build courses around fundamental concepts, ideas and patterns that underpin learners' overall understanding of the subject matter. Learning content in modules and training courses is getting more conceptualized and codified.

Shift towards generic and lifelong learning skills. Rapid increase in information entails fundamental changes in delivering education programs with critical thinking competences, creativity, teamwork skills, and lifelong learning skills prioritized. As long as these competences ensure learners' survival in ever-increasing information boost they impregnate any curriculum design.

Increasing specialization of training programs. Academic disciplines, which have always been indispensable part of any curriculum, are giving way to specified courses which are aimed at training 'narrow' specialists who are well-versed in a specific area of study. Learners at undergraduate and graduate levels are provided with numerous optional courses which grant them an opportunity to gain expertise necessary to effectively tackle a certain issue in their professional domain. This approach to curriculum modernization places particular importance on fostering collaborative skills and welcomes courses designed to facilitate the dialogue between specialists of different field areas.

Interdisciplinary and transdisciplinary curriculum integration. It's a well known fact that exposure to a multitude of training courses and modules frequently results in knowledge fragmentation and lack of integrity in learners' understanding of professional area. A sure antidote to the fragmentation in question is interdisciplinary and transdisciplinary curriculum integration, or, in other words, interdisciplinarity and trasdisciplinarity in education. Interdisciplinary integration seeks to integrate information, data, concepts, tools and techniques from two or more bodies of specialized knowledge to advance learners' understanding of research area and train them to tackle problems whose solution is beyond the scope of a single discipline (Davis, 1995; Jacobs, 1989). Transdisciplinarity of curriculum is targeted at informing learners with concepts, ideas, theories and tools which transcend discipline-specific

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boundaries and constitute theoretical framework of a multitude of disciplines (Davies & Devlin, 2007, Newell, 2006). Interdisciplinary integration can be described as horizontal linkage of curriculum units based on highlighting their shared issues, whereas transdisciplinarity is close to a vertical axis which spans disciplines by emphasizing their similarity in theoretical framework or pattern-based phenomena and processes they study.

The above mentioned four strategies are complementary to each other and are interrelated and overlapping in many ways. For instance, transdisciplinary integration can be viewed as an extension of conceptualization of learning content with the difference residing in the scope of knowledge that is conceptualized. Transdisciplinarity similarly to conceptualization strategy relies on fundamental concepts, ideas and patterns to build a curriculum on, but the latter are identified within the body of knowledge which is not confined to a single discipline, as it was the case in conceptualization described earlier. By the same token, interdisciplinarity contributes to specialization strategy of curriculum modernization as it equips learners with interdisciplinary expertise to harness particular issues. It is reasonable enough to consider all these strategies together and inextricably.

Obviously, interdisciplinarity and transdisciplinarity in education are stipulated by information boost and increasingly complex world issues that are beyond the capability of isolated disciplines to solve them. Although both interdisciplinary and transdisciplinary integration have become the focus of educational policy and their relevance in higher education is evident enough, the practicalities of their implementation into professional education so far remain a scarcely researched area, even less so when it comes to teacher education. Many teacher preparation programs infuse interdisciplinary perspectives by simply adding a couple of courses that are composed of two disciplines, e.g. ‘Psychology of education’, or involve students in creative and project-based activities where knowledge from two or more disciplines is to be utilized, e.g. completing assignments of designing their own serious game. Transdisciplinarity is implemented by requiring pre-service teachers to determine the similarities in the meaning of a scientific term which is interpreted by different disciplines or explore surface level similarities between disciplines.

However, teaching profession, which is highly interdisciplinary in its nature, requires integrating a multitude of disciplinary stances for every single decision-making made in class, and the teacher’s expertise and level of mastery is dependent on his or her interdisciplinary and transdisciplinary competences more than in many other occupations. It is imperative to work out new ways to tap the potential of interdisciplinarity and transdisciplinarity in teacher education.

2. Problem Statement

2.1. Theoretical foundation and related literature

The issue of interdisciplinarity and transdisciplinarity has often featured in educational research. The analysis of scientific literature in this area testifies to a complicated nature of this issue as researchers do not always reach common ground in their critical reflections on when and how to apply integration of disciplines in higher education and in teacher education in particular.

The question of ‘when’ or ‘to what extent’ to integrate disciplines provokes controversy. According to some researchers, interdisciplinary curriculum should only be used to overcome fragmentation in understanding of the phenomenon or to respond to the excessive growth of knowledge

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(Jacobs, 1989). However, the overwhelming majority of scholars maintain that interdisciplinary dimension will always add to the value of curriculum.

In earlier research it was assumed that learners will benefit from interdisciplinary studies only in case they acquire a solid grounding in the various disciplines that interdisciplinarity attempts to bridge (Jacobs & Borland, 1986). Other studies stick to the opposite standpoint and claim that interdisciplinarity, on the contrary, should precede disciplinarity, and 'undergraduate education should consist of more than just the introductory courses from a number of different disciplines. There should be specially designed courses bringing together different disciplines. Disciplinary specialties should then be built upon the foundations of that broad, liberal undergraduate education.' (King, 2010). Almost all the recent studies argue that interdisciplinary and disciplinary approaches to curriculum design are complementary to each other and should be used simultaneously from the very outset of a training program. When the issue of limitations to the use of integrated curriculum in education programs is put into question the argument goes like this: both interdisciplinarity and transdisciplinarity can be applied on unlimited basis provided they leave room for disciplinarity and the balance is not tipped.

Another research challenge is posed by the question 'how' to implement interdisciplinarity and transdisciplinarity in education. Pedagogically, interdisciplinarity can be categorized into three kinds. The first one corresponds to what Klein (Klein, 2002) refers to as parallel, correlated, or sequenced designs where the same or compatible topics coincide or overlap in two or more different courses.

The second one is multidisciplinary design which is focused on a particular problem or a theme (Jacobs, 1989). This problem or theme encourages learners to reveal interdisciplinary connections and synthesize disciplinary perspectives that underpin the solution to this problem or contribute to profound understanding of a theme. As long as learners do it by themselves, their success or failure to forge links between disciplines depends solely on their intuition and mental skills. Therefore researchers express concern about the educational value of multidisciplinary approach.

The third, the infusion model (Klein, 2002), involves blending two or more disciplines into a single one. Education is replete with examples of such blended courses. Still another model of curriculum design defined by researchers is likened to a kaleidoscope (Fogarty, 1991, Beane, 1997) when topics revolve around overlapping concepts and similar patterns taken from variety of disciplines. In our view, this model amply demonstrates transdisciplinarity in education.

Methodology for interdisciplinary and transdisciplinary integration, however, is not confined to choosing the relevant mode of curriculum design. It also implies specific organization of in-class activities. Scientific works provide insight into the specifics of delivering interdisciplinary and transdisciplinary courses by developing some guidelines for teaching stuff.

It is assumed that regardless of the age of learners, when they enrol into interdisciplinary course they should study epistemological issues first, and questions such as "What is knowledge?", "What do we know?" should be at the heart of teaching (Jacobs & Borland, 1986). When an interdisciplinary course starts with the rationale for this course which is made explicit to the audience it is easier to achieve the intended learning outcomes ascribed to the course.

Literature asserts that efficiency of interdisciplinary and transdisciplinary integration is enhanced by multifaceted interaction among learners, and their collaboration with the teacher coupled with inquiry-based actions where individuals learn from one another and share their individual expertise (Karppinen,

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Kallunki, Kairavuori, Komulainen, & Sintonen, 2013). Interdisciplinary understanding of the subject matter suggests generating some cognitive advancement, e.g., explaining a phenomenon, solving a problem, creating a product, raising a new question in ways that would have been unlikely through single disciplinary means (Mansilla, 2005). Hence, an interdisciplinary activity is a process of exchange and cooperation, focusing on the coordination and integration of disciplinary knowledge when addressing a particular issue, object of study or research setting (Fidalgo-Neto, Lopes, Magalhães, Pierini, & Alves, 2014). One of the ways to facilitate collaboration while studying interdisciplinary courses is to create interdisciplinary teams of learners (Full, Dudley, Koehl, Libby, & Schwab, 2015).

Interdisciplinary curriculum should also include multiple service-learning components, so that students could compare and contrast, as well as evaluate and reflect upon, valuable, real-world experiences. These experiences would provide the opportunity to see theory in action and facilitate the transformation of students' knowledge and understanding through praxis (LaFever, 2008).

Interdisciplinary assessments are looked upon as a cornerstone of any interdisciplinary initiatives. Many authors argue that learners should be evaluated by interdisciplinary teams (LaFever, 2008). Currently there are many works on various issues related to quality criteria and interdisciplinary means of evaluating students' performance in integrated curriculum. Most research findings converge on the point that the method of assessment which is chosen for the interdisciplinary course predisposes students' involvement in the course and intensity of their interdisciplinary activity.

2.2. Research problem

With regard to teacher education works on the issue at hand have been long dominated by the idea that the existing theories of interdisciplinary and transdisciplinary curriculum design can be safely extrapolated to teacher training programs as it was confirmed by a multitude of studies. Their analysis gives grounds to conclude that teacher education programs are empowered to initiate different models of interdisciplinary and transdisciplinary curriculum design at undergraduate, graduate and postgraduate levels. However, it is noteworthy that the majority of research studies dedicated to interdisciplinarity in teacher education focus on outlining the syllabus and methodology for one particular interdisciplinary course to use it as a case study for analysis by summarizing the lessons learned. The entirety of the issue is often neglected in the scientific literature. Methodology for running interdisciplinary and transdisciplinary courses with regard to teacher education is a scarcely researched area.

3. Research Questions

What are the main stumbling blocks on the path to integrating ideas of interdisciplinarity and transdisciplinarity and are there any strategies to overcome them in teacher education?

4. Purpose of the Study

The aim of this paper is to extend the scope of traditional approaches to uncovering interdisciplinarity and transdisciplinarity and elaborate on the specifics and practicalities of initiating and implementing integrated curriculum in teacher education programs by identifying pattern-based processes that are integral to running integrated courses.

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5. Research Methods

The paper is focused on theoretical and innovative approaches to curriculum design in teacher training programs. The analysis of psychological, pedagogical, philosophical, methodological literature and case studies of problems that teacher educators encounter in interdisciplinary classes were the main research methods used in this study because they highlight the issues which need to be addressed in the first place when implementing interdisciplinarity and transdisciplinarity in teacher education.

6. Findings

6.1. Main issues that need to be addressed in implementing interdisciplinary curriculum into teacher education programs

The research methods mentioned above enabled the author of the paper to define two main issues that need to be addressed in implementing interdisciplinary curriculum into teacher education programs. The first is choosing the scope and range of disciplines that ought to be integrated in the first place to grant the development of professional competence in pre-service teachers, or the breadth of interdisciplinary integration (Newell, 2002). The second is establishing a clear pathway for applying teaching strategies and learning activities within interdisciplinary framework to promote fast-tracking acquisition of professional knowledge and skills.

6.2. Author's contribution on the existing theory and practice

6.2.1. Integrating interdisciplinarity into teacher education curriculum

The scope and range of disciplines which are desirable for interdisciplinary integration in teacher education programs can be drawn from the understanding of the nature and overall functions of the teaching profession. Every so often teachers have to take decisions which require expertise outside their academic field of study, in other words, outside pedagogy. To qualify for a teaching profession the candidate should demonstrate profound understanding of social and cultural processes that underpin decision-making in education area, the economics context of educational policy and epistemological issues that shape the content of education and teaching practice.

Pedagogy or educational science as a field of study fails to provide a coherent and holistic picture of the interface between education and other systems. Therefore epistemological, cultural, social and economics context of teaching practice should be the province of interdisciplinary endeavours. Such blended courses as 'Culturology of education', 'Educational epistemology', 'Economics of education', 'Educational futurology' are empowered to contextualize knowledge from outside academic disciplines for the benefit of pre-service teachers. But it remains a matter of controversy whether or not these courses are to be taught by pedagogy teachers, teachers of the outside disciplines or an interdisciplinary team.

The real-life application of such interdisciplinary knowledge in professional setting of a teacher is evident enough. Teachers' awareness of the cultural context of professional decision-making enables them to effectively deal with student diversity in class, to approach individually learners of different cultural background, and to adopt foreign practices to the national educational framework. Knowledge of epistemological grounds of education contributes to deep understanding of the nature of teaching and provides outlook for its further development. Educational sociology enables teachers to develop scenarios

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of the future of education in various social contexts and predict consequences of education reforms and, in particular, their impact on the changing structure of society. A mix of pedagogy and economics seeks to foster skills of educational management.

There is sound evidence that in teacher training programs inculcation of interdisciplinary knowledge and skills often occurs on ad-hoc-basis. To overcome this negative tendency a pathway for sequence of teaching strategies should be developed. In order to be beneficial for learning it is imperative for the pathway to mirror stages of the learner's cognitive development. In this paper the author's model for interdisciplinary curriculum implementation is presented.

According to this model at the initial stage of an interdisciplinary course learners are trained to make distinctions between a multitude of contexts in which education systems and teaching practices are likely to evolve. At this stage students study how education practice depends on its context (cultural, social, epistemological, etc.) and how a teacher's decision is reliant on particular context or setting where teaching takes place.

At the second stage learners are supposed to involve in evaluation process. For instance, they can evaluate the relevance of a teacher's decision or teaching method to the context he or she is teaching in. At the third stage of interdisciplinary learning students are encouraged to develop their own creative projects based on their awareness of the link between the teaching practice and contextual variables that determine educational policy. Up to this point they study education phenomena through the lens of one particular context (drawn from the outside discipline).

Beginning from the forth stage prospective teachers are exposed to interdisciplinary activities where they have to take into consideration several contexts at a time. To give a definite example, at the fourth stage students can resort to their knowledge of multi-contextual nature of teaching practice they acquired in the interdisciplinary courses to analyze case-studies from fiction books or films featuring teachers in education setting. Finally, at the fifth stage they embark on a complex creative project on an interdisciplinary education issue with a multitude of contextual variables.

This model shows how a progression of implemented strategies used in interdisciplinary curriculum design complies with students' progression from dependent to autonomous learning with the interdisciplinary creative activity as a final stage. Although the model was developed from teacher education program it is jargon-free and can augment its appeal within other training programs (Figure 01).

6.2.2. Integrating transdisciplinarity into teacher education curriculum

Implementation of transdisciplinarity in teacher training programs can occur either in a specially designed flagship course or in pedagogical disciplines. The overall aim of transdisciplinary approach is not reduced to seeking common theories and concepts in various disciplines. It should be targeted at presenting a new facet or theoretical framework from the outside discipline to describe and explore an educational phenomenon. For example, graduate and postgraduate students can be set the task to analyze current problems in education (or learning methods) in terms of concepts and ideas taken from other disciplines, for example, the concepts of 'synergy', 'linearity', 'fractal structure', 'resonance', 'consensus', etc.

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When the perspective from another discipline transcends the pedagogical perspective of interpretation of educational phenomenon it forms a new holistic approach with the outcome completely different from what one would expect from the addition of the parts. Transdisciplinary transfer promotes students' creativity and lays the groundwork for research activity. Due to transdisciplinary integration pre-service teachers master their innovative skills because perspectives from other disciplines contribute to modifying theory and methods used in education and teaching practice.

The author of the paper has developed some methodology guidelines to implementing transdisciplinary approach in teacher education. From the outset of their transdisciplinary learning only a bare handful of students can experiment with conceptual cross-disciplinary transfer. Therefore it is recommended to start transdisciplinary courses with demonstrating the pervasiveness of some concepts in multiple disciplines and then to discuss constructs, theories and methods from other disciplines that can be expounded to educational theory.

The course should include specific activities to facilitate acquisition of knowledge and skills in conceptual integration. For instance, students can try their hand at transdisciplinary transfer in mental mapping, writing essays, focus group discussions, metaphor searching activities, etc. It is also to their advantage to study journal articles which exemplify the way a concept or a theory from the outside discipline was successfully applied to elaboration on a pedagogical issue. At the end of the course learners are encouraged to create their own transdisciplinary vision of some educational phenomenon and add a new dimension to its interpretation. Here they can turn out the product which is more than sum of disciplinary parts.

Implementation of transdisciplinarity in education is often a challenge but it has profound implications on students' holistic view of professional reality and research skills.

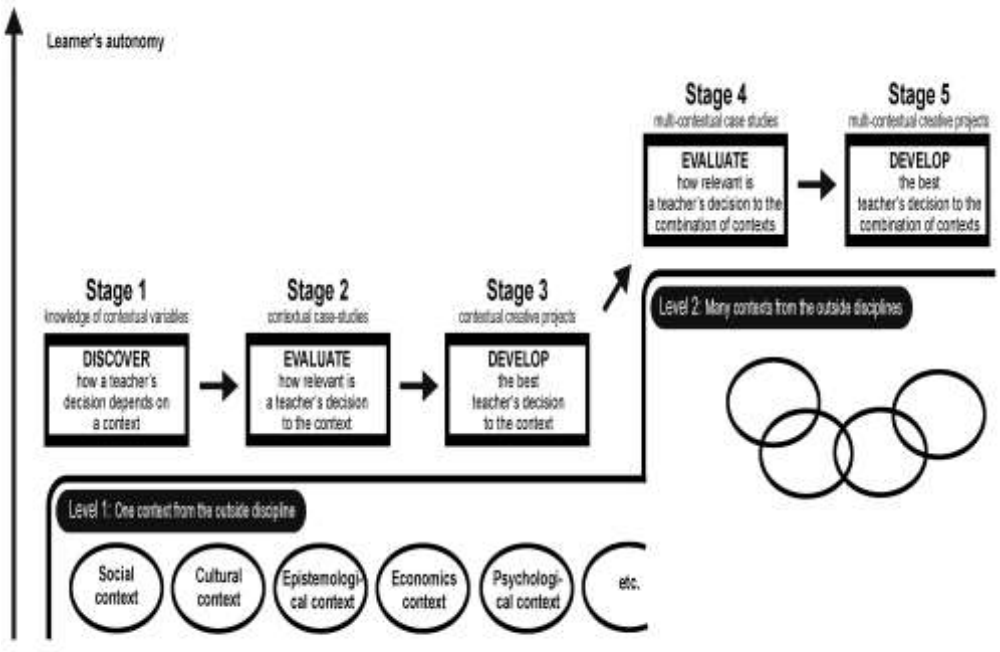

Figure 01. Model for interdisciplinary curriculum integration in teacher education

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7. Conclusion

Our paper tried to draw attention to the fact that initiating interdisciplinarity and transdisciplinarity in teacher education programs offers a multitude of benefits. The first and foremost beneficiaries are pre-service teachers as they get the opportunity to acquire competences instrumental to solving professional problems where knowledge from more than one discipline should be utilized. The second beneficiary is the system of teacher education itself. Integrated curriculum is conducive to teacher education sustainability because owing to integration of disciplines teacher training programs overcome the negative tendencies of fragmentation and lagging behind the time.

Although researchers propose different approaches to integrating interdisciplinarity and transdisciplinarity into education there is still a paucity of literature on the practicalities of its implementation in teacher training programs. This paper innovates by uncovering the pathway for the implementation mentioned above and presents methodology guidelines for transdisciplinary learning and a model for interdisciplinary curriculum as a sequence of teaching strategies which comply with students' cognitive progression.

Yet, the potential of interdisciplinarity and transdisciplinarity in teacher education is not unleashed to the full extent. In our view, the steps along the way to develop interdisciplinary approach in teacher training programs is to incorporate interdisciplinary dialectical problems into curriculum and expose prospective teachers to the real-life situations when two or more disciplines are at controversy with each other in pursuit of the solution and need entering dialectical relations to reconcile. This kind of problems poses a particular challenge for in-service teachers because their capacity to settle such issues requires dialectical thinking which is often overlooked in teacher education programs.

The prospects of further development of transdisciplinary curriculum reside in training students to create a new theoretical framework generated from abstracted ideas and theories of different disciplines so that a professional problem could fit within the new framework to be resolved.

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