PSYCHOLOGY AND EDUCATION (2021) 58(4): 1942-1950
Article Received: 08th October, 2020; Article Revised: 15th February, 2021; Article Accepted: 20th March, 2021

Informatics As A Form Of Indonesia's Future Curriculum

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ABSTRACT

The purpose of this study, which is to describe comprehensively the content curriculum of Informatics as part of digital transformation and at the same time the future skills of students in the field of primary and secondary education. From the study, four things were concluded. First, the content of Informatics developed into a stand-alone subject is interpreted as appropriate because it will produce the human resources needed in the era of the Industrial Revolution 4.0. Second, systematic understanding by education stakeholders about the basic concepts of informatics and information technology and their relevance is very important. Third, the implementation of Informatics Subjects requires teachers who are committed to being creative and intelligent in managing to learn. Fourth, the existence of facilities to support the success of Informatics learning is very necessary.

Keywords

informatics, curriculum, choice

Article Received: 10 August 2020, Revised: 25 October 2020, Accepted: 18 November 2020

Introduction

In early 2018, the Center for Curriculum and Books, as a government institution in charge of compiling curriculum development policy materials, formed a task force (task force) tasked with designing policies, specifically addressing the development of the usefulness of digital technology in learning. The Task Force held a series of meetings on an ongoing basis for approximately six months involving various stakeholders, especially experts in information and communication technology (ICT). From the series of meetings, two recommendations were made. First, in the future education in Indonesia should design content that is full of the "soul" of digital technology into the 2013 Curriculum as a separate subject for SMP / MTs and SMA / MA education units. Second, the content and scope of the structured curriculum design should be following the demands and needs of the times, such as critical thinking skills, computational thinking, work and skills in using and producing technological products, knowledgeable in informatics and technology, and having characteristics in utilizing technology for life.

The demands and needs of future ICT in the digital era above generate various responses. For example, what is the meaning of digital life that needs to be considered together in educational units? What kind of content of the curriculum contains ICT content should educational curriculum developers review? The brainstorming of the experts captured by the task force can be interpreted as giving rise to a variety of syntheses and antithesis. One agrees, with the development of technology from an analogue format to a digital format, especially the digitization of information requires policy response. The digitization of information, which is a product of technology, has led to people's behaviour. More than three decades ago Toffler (1980) revealed his analysis of people's behaviour into three eras, namely the agrarian era, the industrial era, and the information age. The information has a unique quality as a resource and commodity, its usefulness, in combination with its values. others, so versatile and pervasive that they produce a call to history as the "information age" (Kent, et al., 1977).

The information age marked by the increasing importance and availability of all-in-one information has also ushered society into the modern era. The modern era is considered a time in which information has become a commodity that is fast and widespread and easily available, especially through the use of computer technology (Merriam-Webster, 2008). It is called that, because the information conveyed through internet technology is not just an artefact, but becomes a basis, becomes a strength, becomes a competitive advantage, it can even become a flow of knowledge for life. The flow of knowledge through internet technology can accelerate the exchange of information throughout the world. without being constrained by distance and time. Not only that, but internet technology also causes human life patterns to change.

In that context, now several educational units think that the learning model that streams the teaching of knowledge seems less "exciting" when it does not use computers and the internet to manage information. Computers are automatic electronic devices consisting of hardware and software that can compute or process data accurately according to instructed, and provides processing results, and can run multimedia systems (films, music, television, facsimiles, etc.), usually consisting of an input unit, an output unit, a storage unit, and a control unit (Pusat Bahasa, 2008). With the hardware and software, the information entered into the computer will undergo computation so that it turns into a digital technology format.

With the increasing development of digital technology, it has a big influence on one's perspective in living in various professions and lives. This digital technology has now succeeded in making major changes in human life around the world because everyone is free to make good use of it without limits. This development will sooner or later encourage the creation of a new chapter, for example in 2010 the DIGITALEUROPE Forum which has a membership of 60 global companies and 40 national trade associations from across Europe have agreed on the Transformational Agenda for a Digital Age on a productive and innovative digital Europe by 2020. This is driven by the idea that digital technology design will further promote productivity, sustainable growth, innovation and jobs throughout the economy. Europe in multiple ways (www.digitaleurope.org).

Quoting Wajcman (2018) from the title Digital technology, work extension and the acceleration society, in the German Journal of Human Resource Management, states that technology design is important for how a person works, lives and communicates, which in turn regulates their rhythm and social interactions. Sociologically, the digital technology design being developed can encourage the growth of social infrastructures, such as cooperation, creativity, and innovativeness. Therefore, it can be said that digital technology has now become one of the fundamental elements of society. Digital technology changes people's lives. Digital reality is irreversible. Marc Prensky (2001) calls this a very large discontinuity. One might even call it a "singularity," an event that changes things so fundamentally that there is no turning back.

It is like, digital technology is a tremendous menu to feed the wider community the ability to coordinate in the global world. Community life created by the development of digital technology infrastructure not only changes the meaning of time in reaching out (outreach) but also opens up what opportunities can be reached. For example, when Instagram, Facebook, Line, Twitter, or Youtube allow someone to stream information cheaply and easily, liking and sharing as a way of communicating among others is a necessity. Communication has become not only very broad, it has also become much more diverse. The role of digital technology in the information massification process occurs when the results of technology help change communication patterns that are limited by space and time into borderless information communication patterns. With digital technology as a value system and the following work, the practice can spur the acceleration and creation of new networks.

The rearrangement of the curriculum is on the right path in this digital technology era when it is able to change the paradigm of students in terms of: 1) not only passive users in the world they do not understand, but also active and mastering it; 2) having a good understanding of computing concepts will enable students from an early age to make good use of computer systems, and how to solve problems when things don't work properly; 3) able to think computationally so that they will be able to understand rationally about related issues, such as software patents, identity theft, genetic engineering, electronic voting systems for elections, and so on; 4) the digital world is filled with computing and computers, graduates of educational units must have an understanding of informatics; and 5) have equal capabilities with other citizens who are guided by the standards and framework of the Informatics curriculum that have been released and implemented by developed countries, such as those released by the Computing Sector Association (ACM), teacher association (CSTA), and non-profit organizations (code. org) as well as companies that produce information technology that are already global.

So what needs to be observed from all of that? The experience provides notes and understanding, especially at the task force level to conduct studies on curriculum content development as a future need. This need can be interpreted about the importance of a common mind as the basis for a plan to develop curriculum content in the digital era. Notes and understanding for making curriculum designs to build a culture of digitization for students as well as among educators and education personnel that are in line with the 2013 Curriculum are a challenge. Without the same understanding of all elements and lines of the Ministry of Education and Culture regarding the strategies and policies being implemented, it is difficult to realize a harmonious and simultaneous cross-sectoral plan and movement.

With the problems stated above, the purpose of this treatise is to describe comprehensively the contents of the Informatics curriculum as part of digital transformation and at the same time the future skills of students in primary and secondary education. According to Setiawan, digital transformation is also the transformation of civilization. (Kompas, 18/12/2018). The future civilization is closely related to innovation, digitization and technology.

Of the three "keys" innovation plays a very important role. Thanks to digital innovation, it has led to various changes in times that were not known before, such as advances in information technology, one of which gave birth to the Industrial Revolution 4.0 which was driven by data connections on an unimaginable scale. Its ability to create a new depth, expansion and complexity in which human activities are connected through the process of digitization. This is also in line with the statement of Andrew G Haldane (2018) Chief Economist of the Bank of England, in a speech entitled "Ideas and Institutions - A Growth Story", stating that in the future, institutional innovation will be as important as technological innovation if growth economy wants to be maintained.

Concept

Conceptually, in the position of the prime mover of digital technology innovation, it can be interpreted that informatics content is a scientific subject, which is a scientific discipline that seeks to understand and explore problems around humans, both natural and artificially related to the study, structure and nature, design, and implementation of regular computer systems, and an understanding of the principles underlying such design. As a scientific subject, added value, truth, and usefulness are the benchmarks. The narrative revealed by referring to the views of Sowers, et al. (2001) can provide a basis, assumptions and other information regarding the content of this study which can then be further developed into an educational curriculum.

The principle of digital problem solving cannot be separated from two basic concepts, namely "computational thinking" (Computational Thinking / CT) and Information and Communication Technology (Information and communication technology / ICT). Computational thinking is the basis for thinking in the field of informatics. Meanwhile, ICT is theoretically related to the use of various devices and applications to expand access to information and improve human communication processes. The RTR study report in 2006 shows that ICT is a key factor in many interesting things (from rtr). CTs have revolutionized everyday life and affect all areas of society. Therefore, ICTs must be understood and managed considering their significance as one of the most fundamental skills.

Based on the framework as narrated above, there are six main informatics concepts for primary and secondary education that are referred to for review in this treatise, namely (1) German Informatics Society GI (GI, 2008); (2) ACM K-12 curriculum Tucker, A., et al. (2003); (3) BEBRAS from Dagiene and Futschek, 2010; (4) Content of Informatics Education from Dagienė and Jevsikova (2012); (5) K-12 Computer Science Framework (https://k12cs.org/) and CSTA Standards-Computer Science Teachers Association; and (6) Model of Fundamental Informatics Concepts Education from Stupurienė, (2017).

First, the results of the German government through the German Informatics Society GI (GI, 2008) which have developed standard Informatics concepts covering five main areas, Table 1 These five concepts are the proposed standards for informatics education in secondary school grades 5 to 10 in 16 federal states with the same learning goals.

Table 1.GI Content Standards and Process Areas

Content areas	Process areas
Information and data	Modelling and implementing
Algorithms	Arguing and evaluating
Languages and automata	Structuring and networking
Informatics systems	Communicating and cooperating
Informatics, man and society	Representing and interpreting

Second, references to the final report from the ACM K-12 task force curriculum committee submitted in October 2003 on curriculum models for K-12 computer science edited by Allen Tucker (Tucker, A., et al., 2003). This report contains information technology ideas from the National Research Council which illustrates that the concept of information technology has 10 basic ideas that underlie modern computers, networks, and information (National Research Council, 1999) which will produce three domains, namely: understanding of concepts, abilities, and skills. The ten basic ideas are: 1) computer organization, 2) information systems, 3) networks, 4) digital representation of information, 5) information organization, 6) modelling and abstraction, 7) algorithmic thinking and programming, 8) universality, 9) limitations of information technology, and 10) societal impact of information technology.

Third, referrals from BEBRAS to the International Informatics and Computer Skills contest. According to Dagiene and Futschek (2010), there are six important concepts for general informatics education that students must master. Six important concepts, namely 1) Information which includes the conception of information, its representation (symbolic, numeric, graphic), encryption, encryption; 2) Algorithms / Algorithms that include the formalization of actions, descriptions of actions according to certain rules; 3) Computer systems and their applications, which include the interaction of computer components, development, general principles of program function, search engines, etc; 4) Structures and patterns that include discrete mathematical components, combinatoric elements and actions with them; 5) Social effect of technology which includes cognitive, legal, ethical, cultural, integral aspects of information and communication technology; and 6) Informatics and information technology puzzles and information technology which includes logical games, mind maps, which are used to develop technology-based skills.

Fourth, references are based on the conclusions of Valentina Dagienė and Tatjana Jevsikova in the article Reasoning on the Content of Informatics Education for Beginners published in Socialiniai Mokslai (2012) which she calls key informatics concepts for schools (Figure 1).

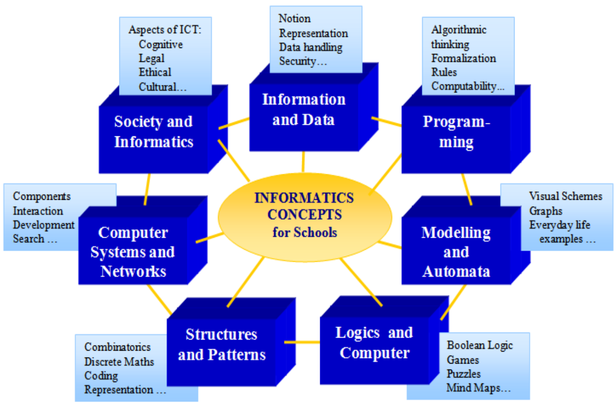

Figure 1. A general scheme of the main informatics concept for schools proposed by Valentina Dagienė and Tatjana Jevsikova which contains seven fields of knowledge, namely 1) information and data/information and data, 2) programming/programming, 3) modelling and automata/modelling and automata, 4) logics and computer/logic and computers, 5) structures and patterns, 6) computer systems and networks, 7) society and informatics/society and informatics

Fifth namely references to the K-12 Computer Science Framework curriculum framework (https://k12cs.org/) and curriculum standards developed by the CSTA Standards-Computer Science Teachers Association (https://www.csteachers.org/page/standards). In the ACM-Association for Computing Machinery document (https://k12cs.org, 2016) it is stated that Computer Science (CS) is a basic subject for the education, career, and future interests of students. The purpose of the Framework for K – 12 Computer Science (Framework for K – 12 Computer

Article Received: 08th October, 2020; Article Revised: 15th February, 2021; Article Accepted: 20th March, 2021

Science) is to define what students in computer science must learn to face the demands of the 21st century. The K-12 Computer Science Framework organizes the pool of knowledge into five core concepts representing major content areas in computer science and seven practices representing the actions learners use to engage with concepts in rich and meaningful ways (Figure 2).

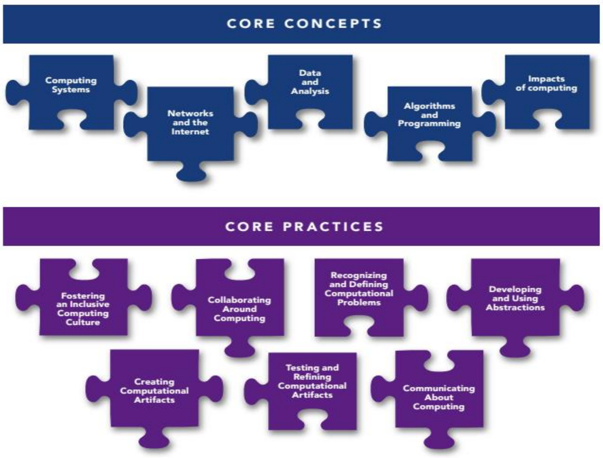

Figure 2. Conceptual Framework and Practice of K-12 Computer Science

From this framework, it is interpreted that informatics content is an important component of modern education in many countries. These countries in designing informatics content curriculum generally adopt two references, namely the K-12 Computer Science Framework (K-12 Computer Science Framework) and the CSTA K-12 Computer Science Standards (CSTA K-12 Computer Science Standards). Likewise, for the development of informatics curriculum content in Indonesia, the task force also adopted this concept.

Based on the adoption of the K-12 Computer Science Framework and CSTA K-12 Computer Science Standards, the task force agreed that the content of the Informatics curriculum in Indonesia consists of four main knowledge component concepts, namely 1) Information and Communication Technology; 2) Thinking Computational (Computational Thinking); 3) Body of Knowledge Informatics which consists of five fields, namely (a) Computer Engineering, (b) Computer Networking (Networking), (c) Data Analysis, (d) Algorithm and Programming (Algorithm and Programming); and 4) Social Impact of Computer and activities for Computing Practice activities. The four main knowledge components and their areas are illustrated like a house building. Figure 3.

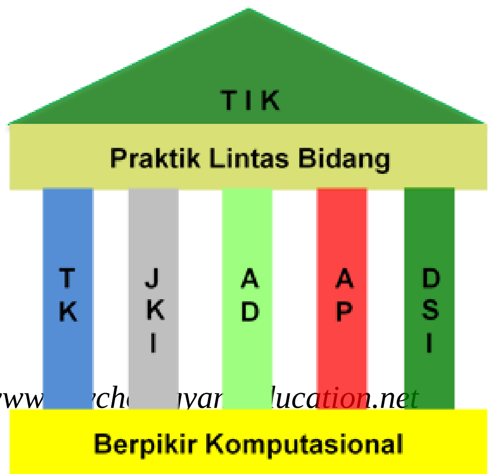

Figure 3. Components of Informatics Content Knowledge Information:

TK	:	Teknik Komputer (*Computer Engineering*-CE)
JKI	:	Jaringan Komputer/Internet (*Networking*-NW)
AD	:	Analisis Data (*Data Analysis*-DA)
AP	:	Algoritma dan Pemrograman (*Algorithm and Programming*-AP)
DSI	:	Dampak Sosial Informatika (*Social Impact of Computer*-SOC)
TIK	:	Teknologi Informasi dan Komunikasi (*Information and Communication Technology* – ICT)
BK	:	Berpikir Komputasional (*Computational Thinking*-CT)
PLB	:	Praktik Lintas Bidang (*Computing Practice*-PC)

In addition to the main curriculum standards as agreed by the task force above, to determine the scope of competence, in developing the curriculum for informatics content, several other related standards were also reviewed, such as ISTE-International Society for Technology in Education

Design

The design of the informatics curriculum content as a process is the totality of the learning experiences of students in one education unit or level to have competence in mastering the content of the informatics aspects designed in the plan. Their learning outcomes are reflected in their overall behaviour in implementing their acquisitions in society. The competency of the informatics curriculum content in educational units is designed to focus primarily on the skills needed in the context of societal problems.

Diagrammatically, the informatics content design framework is presented in Figure 4

Figure 4. Informatics Concept Design

Source: Description of the Informatics Curriculum Development Task Force, Puskurbuk, 08022019

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Based on Figure 4, the following sections describe the design directions of each informatics component in sequence.

First, the Information and Communication Technology component. ICT is related to the use of computer systems to solve real-world problems, including to support tasks of other subjects, specification and installation of hardware, software, and network infrastructure, and evaluation of their usefulness. ICT is the productive, creative and explorative use of technology.

Although in some developed countries the "teaching" of ICT has been abolished, ICT is part of the ability to utilize technology which is deemed necessary to be taught in Indonesia, because almost all fields require computers. In this sense, ICT as a "tool" is not a learning goal. ICT is used to support the objectives of other subjects, which require ICT support. The expected ability of students in ICT learning is to use ICT to achieve "goals" (goals), not learning the use of applications or computer devices. For example, in the use of office application packages, such as the ability to 1) use a word processing application to create reports both in terms of content and format, 2) make good use of number processing applications for data analysis and interpretation, 3) make good use of material processing applications presentations to support a more communicative presentation in delivering scientific research results

The use of ICT designed in informatics content is expected to form a systematic work pattern of students so that results/objectives can be achieved efficiently and optimally. ICT is a tool in problem-solving

The scope for primary school lies in the emphasis on Computing for fun. Students in primary school use ICT and a foundation of computational thinking to apply it in everyday life and realize the impact of ICT products on themselves. This shows that the affective and motor skills of students are more concerned with cognitive abilities

In junior high school, the scope of Information Technology is emphasized as a tool and at the same time an introduction to Informatics. Students take advantage of technology, experience and identify (seeing in the mind eyes) regarding the concept of information technology, and produce simple informatics products, and are aware of their impact on themselves and their surroundings.

Whereas for senior high school students, the scope of the design is directed as Basic Informatics Sciences. In that sense, students learn more abstract scientific aspects of informatics, which are applied through digital products and social aspects.

Second, the component of Computational Thinking. Computational thinking (berpikir komputasional) is one of the important abilities of the 21st century which has started to be grown from an early age in developed countries. Computational thinking is also a major capability in the field of Informatics. It is the ability to think to solve problems whose solution is related to "computing". Computing is either arithmetic or the form of steps that follow a well-defined model, namely algorithms. Computing is an important aspect of the Informatics or Computer Science discipline.

Currently, computers are a tool to solve problems and support the functioning of almost all other fields of science, so that computational thinking influences other fields such as biology, chemistry, medicine, linguistics, psychology, economics, statistics and others. computational thinking ability will help someone to solve problems, design systems, understand human strengths and limitations, as well as build computer systems, robots, and even intelligence machines, including in the field of artificial intelligence (AI), which are related to other disciplines.

Computational thinking is oriented towards "problem-solving" so that it makes one's thinking power develop. A person who can think computationally will be able to think at a high level and analytically, so that he can more easily conceptualize and understand computer-based technology, and have more competitiveness in today's world which has entered the Industrial Revolution 4.0 which produces smart factories than anything else. based on cyber-physical systems, IoT (Internet of Things), cloud computing, and cognitive computation.

The ability to solve problems (problem-solving) is an ability that is needed both for studying and at work. Nowadays is the "information age", computers are increasingly needed in everyday life, society and profession. Therefore, computational thinking needs to be introduced as early as possible. Apart from being designed in the informatics curriculum content, other ways are needed to introduce and also make students interested, for example through "competitions", "challenges", or "Olympics". At the international level, for example, competitions related to computational thinking skills are the IOI (International Olympiad in Informatics) and the Bebras Challenge (Bebras Challenge). Easy with this, based on information from the World Economic Forum, the three main skills needed in the world of work in 2020 are complex problem solving, critical thinking, and creativity (Schwab, 2016).

In several studies, computational thinking includes the ability to perform decomposition, abstraction, algorithmic thinking and the formation of solution patterns that are the basis for building a computerized system. With BK, a person integrates problem-solving experiences and forms a solution pattern that allows him to not only be able to solve a problem at hand but also to solve similar problems with smarter, more efficient and optimal solutions. Operationally, BK plays with 1) logic and analytic predictions; 2) organizing and analyzing data; 3) represent data through abstractions such as models and simulations; 4) automating solutions through algorithmic thinking; 5) identify, analyze, and implement possible solutions to achieve the most efficient and effective combination of steps and resources; and 6) generalizing and transferring this problem-solving process to various problems (ISTE and CSTA, http://csta.acm.org, 2011; Barr, Harrison and Conery, www.iste.org, 2011).

Third, the components of the Informatics Science Sector. Informatics deals with how computers and computer systems function, as well as how a computer system is designed, programmed and realized. Informatics is a subject that is "theoretical" and at the same time "practical", where students are encouraged to make inventions and develop minds to apply computational concepts into useful artefacts. Students are expected to apply the scientific principles they have learned in identifying and understanding problems in the real world and then creating useful artefacts as solutions to these problems. The combination of principles, practice, and invention makes students creative and feels the realization of digital products that are both useful and contain beauty.

Discussion

At the time of writing, Permendikbud Numbers 35, 36, and 37 of 2018 are not yet available. However, the Informatics Subjects listed in these laws and regulations stems from the framework developed by the task force for a long time. Currently, these subjects seem to revolve around how to implement and how teachers teach them. Two issues are quite complicated because they must be in line with the design of the 2013 Curriculum and at the same time be in line with the draft concept of informatics content.

One of the educational curriculum content that all students must have after completing their education at one education unit or level is quality informatics to meet future demands. The future of the field of Informatics becomes the foundation and principles for solving problems that will be solved with the aid of computers as a means of building an understanding of the central concepts and principles of how technology is behind the increasing work of digitization and how to use these technologies to create their artefacts in their implementation.

The implementation of the Informatics Subject curriculum is a written plan in the real form in the study room so that there is a transmission and transformation process that describes the content and learning methods of the learning experience of students. The learning experience of students must be in line with the main theme of the development of the 2013 Curriculum, which is a curriculum that can produce productive, creative, innovative, and effective Indonesians through learning based on strengthening religiosity, question attitudes, skills, and knowledge which are all integrated into learning.

The centre of the learning outcomes of students is in each educational unit. Therefore, the education unit in implementing Informatics Subjects must have the spirit that the institution is an integrated educational institution and the curriculum is an educational unit curriculum, not a list of subjects. Teachers in education units must play a role as a team of the community of educators, who are committed to developing informatics curriculum learning together.

Such a frame of mind must be interpreted that the education unit must be a very dynamic field in developing Informatics Subject learning, including new knowledge, and striving for good things to improve the performance of students who are today's millennial style. Students must have the courage to share skills in collaboration obtained from learning information on learning, leadership, and communication.

The characteristics of the field of Informatics are very challenging, this is what needs to be managed properly in learning in educational units. Informatics learning governance must rely on school-based management which is packaged to embody the repositioning of the informatics content paradigm from "Informatics as an unknown curriculum content" to "fun informatics" which in turn is the basic capital for human resource development digital and multiplier effect for the national economy. Such an implementation strategy will provide a foundation and strong character values that are grounded in the framework of modern human resource development. Where the concept of informatics is the root of the digital world that characterizes the global community to work.

Students who work (whatever the form of their work) means making achievements with the productivity of the work, maintaining local wisdom, having a constructive mindset, contributive attitudes, and a collaborative spirit in taking roles for the surrounding community. Working in the context of Informatics is by showing concern for others through the presence of digital innovation, as well as being more creative and wise in utilizing the internet, producing quality content, using local domestic products, preserving cultural values with sustainable program activities, utilizing regional potential and wisdom for technological products of value.

This is in line with the spirit of the material and competencies (core competencies and basic competencies) defined in the Informatics curriculum by referring to curriculum standards that apply internationally. By referring to the standard and aspired core competencies and basic competencies, the implementation of the Informatics Subject curriculum must be carried out based on the design of the teaching process that is compiled "creatively" by each teacher. The demands of teacher creativity must also be adjusted to the context and the availability of facilities that can be used to support teaching. Teachers need to think critically, collaborate, and be creative in designing ways of delivery and cases that are appropriate to the local, national, and international context in achieving the set learning objectives.

The point is that core competency and basic competencies Informatics are designed not for “one for all” implementation, but to accommodate the delivery methods and local cases that are most suitable for the situation and conditions of students in the regions and each educational unit.

The success or failure of implementing the curriculum does not only depend on the design of KI and KD but is also determined by the available resources, especially teachers and the facilities and infrastructure to support informatics learning for students. In this context, informatics teaching materials as part of the learning plan should be developed by teachers who are reliable and competent and delivered with a higher-order thinking skills (HOTS) approach so that they can carry out the implementation of informatics well.

For this reason, teachers are required to develop teaching skills actively by learning from the given sources, not just waiting for opportunities to attend training or get ready-to-serve teaching materials. Teacher unions, for example, can be empowered as a forum for teachers to come together to keep up with the fast development of science and technology, especially in the field of informatics. We recommend that the teacher association also hold joint learning activities and share experiences. If necessary, invite competent sources. Because Informatics is a relatively young discipline, it should learn a lot from various sources, such as reputable university lecturers to organize computing study programs.

To accommodate the dynamics and creativity of teachers in compiling teaching materials so that learning materials are dynamic, easily updated, and can be composed according to needs, it is necessary to build a repository of all artefacts resulting from the implementation of the Informatics curriculum. Learning Material Repository is a system (server, application, database) which will be used to store all resources related to the implementation of the National Informatics curriculum. The contents can be in the form of files, videos, images, text, computer programs, which are given "metadata" (information about the content) so that it is easily accessible to certain categories.

Each specific teaching group in a region should build its repository that can be used to store all the teaching material that peer teachers have developed. Thus, the existence of material that has been reviewed by competent people for quality, can be shared as a source of inspiration for other teachers, especially those who have just started teaching Informatics Subjects or even from other group teachers. Meanwhile, the government should also create a repository that all interested parties can easily fill in gradually with selected artefacts because their quality is guaranteed. In this way, teachers everywhere will be able to access what is needed because the page is available as national resources.

Conclusion

From the results of the discussion above regarding the content of the Informatics curriculum, several things can be concluded. First, the informatics content developed into an independent subject is interpreted correctly because it will produce the human resources needed in the era of the Industrial Revolution 4.0. Second, systematic understanding by educational stakeholders of the basic concepts of informatics and information technology and their relationship is very important. Third, implementing Informatics Subjects requires teachers who are committed to being creative and intelligent in managing to learn. Fourth, the existence of facilities to support the success of informatics learning is very much needed.

References

[1] Barr, D., Harrison, J., and Conery, L.. (2011). Computational Thinking: A Digital Age Skill for Everyone, ISTE (International Society for Technology in Education), 1.800.336.5191 (U.S. & Canada) or 1.541.302.3777 (Int’l).

[2] Barr, V. and Stephenson, C. (2011). Bringing computational thinking to K-12: what is Involved and what is the role of the computer science education community?, in ACM Inroads archive, vol. 2 no. 1, March 2011, pages 48-54, http://dl.acm.org/citation.cfm?id=1929905.

[3] Bauer, W.F. (1996) ‘Informatics and (et) Informatique.’ Annals of the History of Computing, 18(2). http://www.softwarehistory.org/history/Bauer1.html.

[4] Berger, R. (2015). Strategy Consultants, Bundesverband der Deutschen Industrie e.V. (BDI – Federation of German Industries), The digital transformation of industry, Sederanger 1, 80538 München, Germany, www.rolandberger.com..

[5] Brey, P. and Søraker, J. (2009). ‘Philosophy of Computing and Information Technology’ Philosophy of Technology and Engineering Sciences. Vol. 14 of the Handbook for Philosophy of Science. (ed. A. Meijers) (gen. ed. D. Gabbay, P. Thagard and J. Woods), Elsevier.

[6] Caspersen, M. E., Gal-Ezer, J., McGettrick, A. and Nardelli, E. (2018). Informatics for All The strategy, ACM Europe & Informatics Europe, Report, February 2018, pada https://www.acm.org/...policy/acm-europe-ie-i4all-strategy-2.

[7] Cassel, L. N. (2007). Understanding the Entirety of Modern Informatics, Innovation in Teaching and Learning in Information and Computer Sciences, 6:3, 3-11, 2007.

[8] Dagiene, V. (2006). The Road of Informatics: To the 20 Years Anniver¬sary of Teaching Informatics in Lithuanian Secondary Schools, Vil¬nius (2006).

[9] Dagienė, V. and Stupuriene, G. (2016). Informatics Concepts and Computational Thinking in K-12 Education: A Lithuanian Perspective, Electronic Preprint for Journal of Information Processing Vol.24 No.4, Invited Paper, 2016.

[10] Dagienė, V. and Jevsikova, T. (2012). Reasoning on the Content of Informatics Education for Beginners, ISSN 1392 –

0758 SOCIALINIAI MOKSLAI. 2012. Nr. 4 (78).

[11] Dagienė, V. and Sentance, S. (2016). It's computational thinking! Bebras tasks in the curriculum. In Lecture Notes in Computer Science (Vol. 9973). SpringerVerlag Berlin Heidelberg.

[12] Dagienė, V., Futschek, G. (2010). Introducing informatics concepts through a contest. In: Proceedings of the IFIP working conference: New developments in ICT and education. Amiens: Universite de Picardie Jules Verne. Paper-No 7, 1–15.

[13] Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P. and Sysło, M. M. (2017).Computer science in K-12 school curricula of the 2lst century: Why, what and when?, Education and Information Technologies, March 2017, Volume 22, Issue 2, pp 445–468.

[14] Dreyfus, Ph. (1962) ‘L’informatique.’ Gestion, Paris, Juin 1962, pp. 240—1.

[15] Fourman, M. (2002). Informatics, Informatics Research Report EDI-INF-RR-0139, Division of Informatics, July 2002, http://www.informatics.ed.ac.uk/.

[16] Gal-Ezer, J. and Stephenson, C. (2014). A tale of two countries: Successes and challenges in K-12 computer science education in Israel and the United States, ACM Trans. Computing Education (TOCE), Vol.14, No.2 (2014).

[17] Gander, W., Petit, A., Berry, G., Demo, B. and Vahrenhold, J. (2013). Informatics education: Europe cannot afford to miss the boat, Report of the joint Informatics Europe & ACM Europe Working Group on Informatics Education, April 2013.

[18] Gesellschaft für Informatik (GI) e.V. (2008). Grundsätze und Standards für die Informatik in der Schule, Bildungsstandards Informatik für die Sekundarstufe I. Addendum to LOG IN 28 (150/151).

[19] Guerra, V., Kuhnt, B. and Blöchliger, I. (2012). Informatics at school-Worldwide:An international exploratory study about informatics as a subject at different school levels 2012. Hasler Stiftung, Universisität, Zürich UzH.

[20] Haldane, A. G. (2018). Pidato Chief Economist Bank of England, yang diberi judul “Ideas and Institutions – A Growth Story”

[21] Hawkrige, D. G. (1996). Educational Technology in Developing Nations,

[22] Kent, A., Lancour, H. and Daily, J. E.. (1977). Encyclopedia of Library and Information Science. Boca Raton, Florida: CRC Press.

[23] Plomp, T. and Ely, A.D. (eds.), International Encyclopedia of Educa¬tional Technology, Great Britan, Pergamon, 2nd edition, pp.107-111.

[24] Pusat Bahasa. (2008). Kamus Bahasa Indonesia. Jakarta: Depdiknas.

[25] RTR/Schriftenreihe der Rundfunk und Telekom Regulierungs-GmbH. (2006). ICT best practices in Denmark, Estonia, Finland, the Republic of Korea, Sweden and Switzerland, Oktober 2006

[26] Sanders, M. (2009). STEM, STEM education, STEM mania. The Technology Teacher, 68(4).pp. 20-26.

[27] Schwab, K. (2016). World Economic Forum Annual Meeting 2016, Mastering the Fourth Industrial Revolution. www.weforum.org.

[28] Setiawan, S. (2018). Transformasi Peradaban Digital Mulai 2020, Kompas, Selasa, 18 Desember 2018, Hal. 6.

[29] Sowers, K., Ellis, R. A., and Meyer-Adams, N. (2001). Literature reviews. Dalam B. A. Thyer (Ed.), The handbook of social work research methods. Thousand Oaks: SAGE Publications, Inc.

[30] Stupurienė, G. (2017). Model of Fundamental Informatics Concepts Education , October 2017, Technical report MII-DS-07T-17-02, VU Institute of Mathematics and Informatics, Akademijos str. 4, Vilnius LT-08663, Lithuania.

[31] Syslo, M.M. and Kwiatkowska, A.B. (2013). Informatics for all high school students: A computational thinking approach, Pmc. Intl. Conf. on In¬formatics in Schools: Situation, Evolution, and Perspectives, pp.43- 56, Springer-Verlag.

[32] Wajcman, J. (2018). Digital technology, work extension and the acceleration society, German Journal of Human Resource Management, First Published 8 May 2018.

[33] Wing, J. M. (2006). Computational thinking. Communications of the ACM, Vol. 49(3), pp33-35.

[34] www.digitaleurope.org. (2010). DIGITALEUROPE VISION 2020: A Transformational Agenda for the Digital Age