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Transformation of Elementary School Teacher Competencies in the Digital Age: Analysis of the Spencer Model in Coding and AI Training in Pinrang Regency

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A B S T R A C T

This study analyzes the effectiveness of human resource development for elementary school teachers in Pinrang Regency through training in coding and artificial intelligence (AI), using Spencer and Spencer's competency theory approach. Method: This descriptive qualitative study involved training participants as key informants selected through purposive sampling. Data were collected through interviews, observations, and documentation, then analyzed using the Miles and Huberman model. Results: Findings show that the aspects of teachers' motives, traits, and self-concept are in the optimal category. Teachers were highly enthusiastic about digital innovation. However, the knowledge and skill aspects still faced significant obstacles, mainly due to non-linear educational backgrounds and network infrastructure barriers in the dissemination process to schools. Implications: This study recommends the need for policy interventions that not only focus on technical training but also infrastructure support and continuous mentoring to ensure effective knowledge transfer

INTRODUCTION

Development is not always about infrastructure, but also about human resource development. Developing human resources is key to the successful implementation of programs because it provides competent resources. Human resource development is essential to increase human resource productivity. Human resources play a decisive role in the success of policies, programs, and government performance, so they need to be nurtured and developed in order to contribute optimally to an organization.

Terminologically, according to Syed Agung Afandi (2019), development is synonymous with the terms development, modernization, westernization, empowering, industrialization, economic growth, Europeanization, and political change. In today's digital era, coding and artificial intelligence have become tools for teachers in elementary, middle, and high schools in teaching the existing curriculum. Therefore, to implement coding and artificial intelligence, there needs to be human resources capable of supporting the use of artificial intelligence in schools.

Human resource development must be carried out consciously, comprehensively, systematically, gradually, and continuously. Therefore, coding and artificial intelligence training for elementary school teachers in Pinrang Regency is expected to develop creativity and improve the quality of schools in Pinrang Regency.

According to R. Wayne Mondy in Niati et al., (2019), training and development are at the heart of ongoing efforts to improve employee competence and organizational performance. When conducting training, the knowledge and skills needed for the job will be acquired so that they can be optimally utilized through the creation of a workforce that fulfills the motto of The Right Man On The Right Job At The Right Time, namely the right person, the right job, and the right time, all of which can support organizational performance management. Performance management is a goal-oriented process aimed at ensuring that organizational processes are running to maximize the productivity of employees, teams, and the organization.

According to Hasan et al., (2023), in order to build human capital that meets current and future demands, it is necessary to identify the required competencies, such as skills, knowledge, attitudes, and motivation. Furthermore, in the 4.0 industrial revolution, workers are needed who are well-versed in the technology of things (TOT), human-machine interaction, interface technology, and have a good understanding of networking systems. Thus, with human capital as capital, superior, creative, and innovative human resources will be created that are adaptive to global changes in this era of the 4.0 industrial revolution.

Based on data from the Central Statistics Agency (BPS), coding and artificial intelligence training shows positive potential and has an impact on Pinrang Regency. There are 640 elementary schools (SD), 114 junior high schools (SMP), and 28 senior high schools (SMA) in Pinrang Regency. This data shows that coding and artificial intelligence training can reach many teachers and contribute

significantly to improving the quality of education in Pinrang Regency (*[Metode Baru] Indeks Pendidikan, 2023*, n.d.).

Although the integration of technology in education has been widely discussed, the majority of previous studies have focused on the acceptance of technology in urban areas or higher education (Muin et al., 2023). There is still little literature evaluating the readiness of elementary school teachers in developing regions (such as Pinrang Regency) to adopt complex technologies such as coding and AI. This gap is important to study because digitization policies often fail not because of the technology, but because of the unpreparedness of the soft competencies of the implementing human resources. This article aims to dissect these dynamics using the lens of Spencer and Spencer's Competency Theory, in order to provide a roadmap for local governments in formulating more targeted teacher human resource development policies.

LITERATURE REVIEW

According to Sutrisno in Jusriadi et al.,(2021), competence is an ability based on work behavior and its application in carrying out tasks and work in the workplace that refers to established work requirements. According to Miller, Rankin, and Neathe in Jusriadi et al. (2021), initially there were only two types of rapidly developing definitions of competency. The first was technical/functional competencies, defined as a description of what a person must know or do in order to perform their job well. The second type of competency is behavioral competencies, which describe how a person is expected to behave in order to perform their job well (Anto et al., 2026).

According to Spencer and Spencer in Busro (2018), competence is a characteristic that underlies an individual's effectiveness in their work or a basic characteristic of an individual that has a causal or cause-and-effect relationship with the criteria used as a reference, effective or excellent or superior performance at work or in certain situations.

Meanwhile, according to Spencer and Spencer in Jusriadi et al. (2021), competence is something that underlies individual characteristics, leading Spencer to develop a theory of competence with five variables, namely:

a. Motive, something that is consistently thought about and causes action.
b. Traits, physical characteristics, and consistent responses to situations and information.
c. Self-concept, a concept that encompasses a person's attitudes, values, or self-image. Self-confidence is the belief that one is capable of adapting to any situation.
d. Knowledge, information possessed by people in a specific field.
e. Skills, the ability to perform physical tasks or specific mental abilities.

From the theoretical discussion above, it can be concluded that competence is everything that a person possesses in the form of knowledge, skills, and other internal factors that enable them to perform a job based on their knowledge and skills.

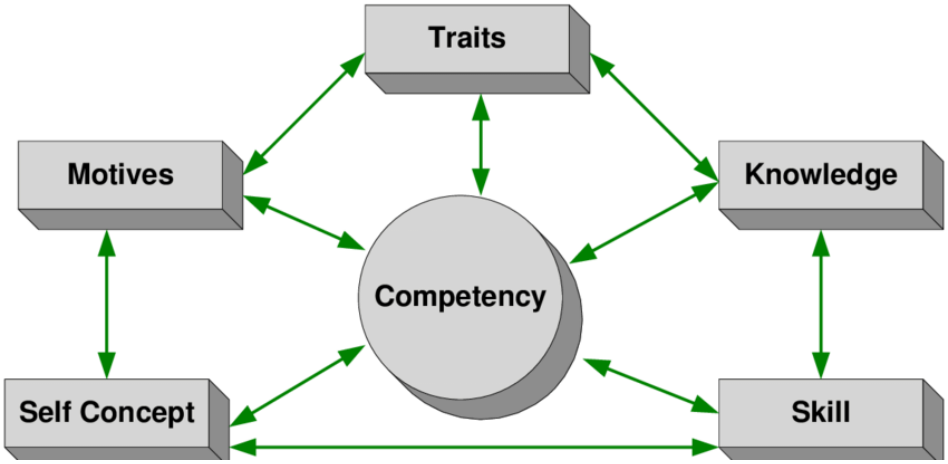

Figure 1. Competency Theory by Spencer and Spencer in Jusriadi et al., (2021).

From the image above, we can conclude that competencies in the form of knowledge and skills tend to be more visible and relatively superficial, and are one of the characteristics that humans possess that are relatively easier to develop through experience or training. From Figure 1 above, we can also conclude that each variable must be fulfilled in an individual in order to achieve individual competencies that can support optimal organizational performance.

The Ministry of Primary and Secondary Education (2025) states that Coding and Artificial Intelligence (KKA) training is training that utilizes technology which is then applied in primary and secondary schools so that the digitization of education can be realized. In the Minister of National Education Regulation No. 16 of 2007 concerning Academic Qualification Standards and Teacher Competencies, the pedagogical competency mentions the use of ICT for learning purposes. Furthermore, in the professional competency section, it is stated that teachers must utilize ICT for communication and self-development. In addition, Government Regulation of the Republic of Indonesia No. 74 of 2008 concerning Teachers, article 3 paragraph 4, also states that one of the professional competencies that teachers must master is knowledge in the fields of science, technology, and arts and culture.

Coding and Artificial Intelligence (AI) learning aims to prepare students to master certain concepts and competencies in accordance with their developmental stages. Several references are used as references in the development of these concepts and competencies, including the UNESCO ICT Competency Framework for Teachers (2018), UNESCO AI Competency Framework for Students (2024), UNESCO K-12 AI Curricula (2022), and Computer Science Teachers Association (CSTA) K-12 Computer Science Standards (2017) (Ferrari & Punie, 2013).

According to Law No. 20 of 2003, a curriculum is a set of plans and arrangements regarding the objectives, content, and subject matter, as well as the methods used as guidelines for conducting learning activities to achieve specific educational goals. Curriculum development is a systematic effort to adapt to the needs of students, the changing times, and educational goals. The scope of the

curriculum is not limited to intracurricular activities, but can also be applied to cocurricular or extracurricular activities. The following section will describe how the Coding and Artificial Intelligence (AI) curriculum is designed based on the competencies that students must master at the end of each level, the options for implementing Coding and AI content that can be applied in educational units, the Coding and AI learning materials and outcomes at the end of each grade range, several learning methods that can be used, and the learning media.

Coding and AI learning aims to develop students' competencies in accordance with their developmental stages. According to Mills in Inda (2024), coding and AI are easy-to-use applications that educators can use to create learning media, animated learning videos, and digital-based teaching materials. Based on Permendikbudristek No. 12 of 2024, coding and artificial intelligence training is training to equip teachers with basic knowledge and skills in the field of technology, as well as encourage them to integrate this technology into contextual and meaningful learning. Elementary school teachers are given more basic material, including an introduction to coding and AI topics in the context of the national curriculum, computational thinking as a foundation for logic, an introduction to AI concepts, the simple use of AI in learning, and pedagogical strategies relevant to the characteristics of elementary school students.

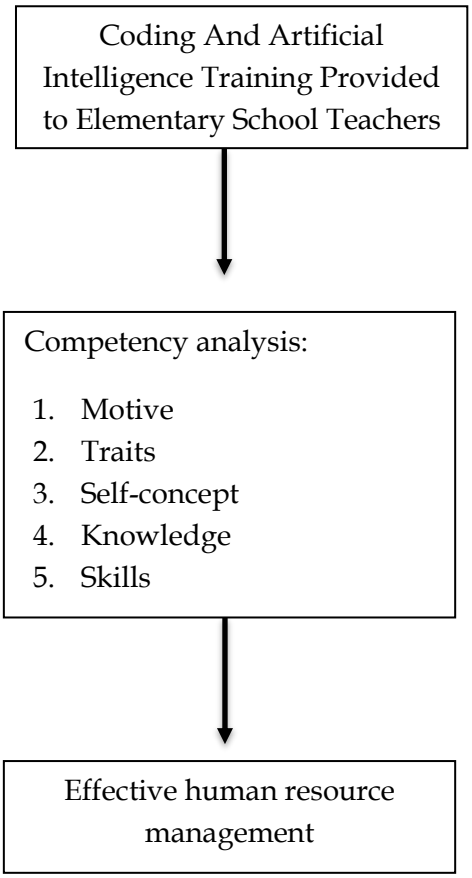

Figure 2. Conceptual Framework by Nurul Ayuni (2026)

METHODOLOGY

This study uses a qualitative approach to understand the research focus comprehensively. Qualitative methods were chosen to find in-depth information about the phenomenon being studied. The database was found through observation and direct interviews with research informants. Research informants in the interviews were selected using a purposive procedure, which means that informants were deliberately selected based on their understanding of the issues in this study (Rezeky et al., 2024). This study used a qualitative approach with a case study design. The research location was in Pinrang Regency, focusing on Coding and Artificial Intelligence (KKA) training.

Based on this, the researchers have determined the informants in this study, namely participants in the Coding and Artificial Intelligence (KKA) training in Pinrang Regency. The supporting database was obtained through library research, referring to popular references in line with the focus of the study, such as articles, scientific papers, books, documents, and other electronic publications (Rezeky et al., 2024).

Data analysis in this study, as explained by Miles and Huberman in Supriyanti et al., (2025), consists of three stages. First, data reduction. The data obtained will be selected and adjusted to the focus of the study to facilitate the presentation of the research results. Second, data presentation, which is carried out descriptively and presented rationally, logically, and systematically so that it is easy to understand. Third, Verification and Drawing Conclusions. At this stage, the data is identified and then linked to form a systematic pattern and structure. The results of this processing become research findings from which conclusions can be drawn.

RESULT AND DISCUSSIONS

To see the extent of the success of coding and artificial intelligence training on human resource development, specifically for elementary school teachers in Pinrang Regency, the author uses the competency theory proposed by Spencer and Spencer. Spencer argues that individual competence is something that underlies the characteristics of each individual in carrying out their main tasks and functions. Therefore, it is important for every human resource to be aware of the coding and artificial intelligence programs that they want to implement in their schools. Spencer also argues that there are several key variables that play an important role in determining individual competence. These variables are detailed as follows:

a) Motives

Spencer and Spencer say that motives reflect what an individual thinks, desires, and drives them to act. In other words, motives are the driving force that makes individuals enthusiastic and strive to achieve their goals.

Based on interviews with teachers who have participated in KKA training in Pinrang Regency, they want to gain knowledge and then implement creative innovations in every classroom lesson using the artificial intelligence skills they have acquired through KKA training in Pinrang Regency. The interview results show that teachers have a strong motivation to innovate. However, there is a

dualism of institutional motives. Only 72 of 640 schools participated due to the requirements of the BOS Kinerja (School Operational Assistance) funding.

To see whether the KKA training in Pinrang Regency was successful or not, we can also look at the participation of schools in the KKA training held by the government. Of the 640 elementary schools in Pinrang Regency, only 72 schools participated in the training. This was because the schools that participated in the training were recipients of the School Operational Fund (BOS) Performance. Schools that did not participate were those that did not receive BOS Kinerja funds. From this, it can be concluded that the motivation of elementary schools in Pinrang Regency is still not optimal to be able to implement KKA. This is because schools are unable to support the development of teachers' skills and the internet network in each village is not adequate.

These findings are in line with the Public Service Motivation (PSM) theory, which states that teachers have high individual motivation, but are hampered by the rigidity of the budgeting bureaucracy. This confirms Wahyudi (2022) study, which states that the motivation of regional teachers is often "stunted" by limited administrative support.

So, broadly speaking, every elementary school has a motive, but only 72 of the 640 schools have a strong motive to develop their human resources through coding and artificial intelligence training.

b) Traits

According to Spencer in Jusriadi et al., (2021), character describes an individual's mental characteristics, reflecting how they react to various situations, pressures, and information. Character shows consistency in wisdom and actions, thereby revealing an individual's true self.

To develop human resources, it is also necessary to have a character that can accept changes from traditional to modern situations. Similarly, with coding and artificial intelligence, teachers need to be adaptable and consistent in implementing digital transformation in education. Given the importance of coding and artificial intelligence learning as part of digital literacy and computational thinking development in elementary school, teachers need to have the mindset to face these changes.

Based on the interview results, teachers demonstrated adaptive characteristics even though the majority were "digital immigrants." Their self-concept was positive, viewing AI not as a threat but as a pedagogical partner. The acceptance of the material by each teacher who participated in the KKA training can be considered optimal. This can be seen from the teachers' active participation during the training. LPD UNM revealed that the training material was compiled based on the participants' needs and tailored to the direction of strengthening teachers' competencies in the digital era. As a result, teachers who participated in the training were able to easily accept and adapt to computational thinking.

In contrast to the findings of Fikri et al., (2021), who found resistance to technology among older teachers, teachers in Pinrang showed good acceptance. This indicates that "down-to-earth" and contextual (simple pedagogical) training methods were successful in building teachers' self-efficacy.

b) Self-concept

To prepare competent human resources, from the perspective of the theory of capital agency possessed by an individual, in this case educated and skilled human resources, who are ready to compete with other human resources. Those who have these competencies will be able to win the global competition.

According to Spencer and Spencer, self-concept refers to an individual's understanding of themselves, particularly in terms of their attitudes, values, and views regarding their work, duties, or position. Self-concept influences an employee's motivation and work style.

Based on interviews and field observations, the educational backgrounds of elementary school teachers in Pinrang Regency vary. Therefore, in participating in KKA training, more basic material is needed to understand the concept of computational thinking. Knowledge variables are a major obstacle. The generalist educational background of elementary school teachers (classroom teachers) makes it difficult for them to absorb specific programming logic. The training material from LPD UNM has been simplified, but the gap in basic ICT knowledge is still evident. LPD UNM strives to introduce the simple use of artificial intelligence in a pedagogical manner by broadening teachers' understanding of how artificial intelligence can be used as a teaching aid and a source of technology-based student projects. This is a classic phenomenon in public sector human resource management. As mentioned by Rahman and Watanobe (2023), short-term technical training (short courses) is not sufficient to address the deficit in foundational competencies. A continuous professional development (CPD) model is required.

So, in general, it can be concluded that although the educational backgrounds of elementary school teachers in Pinrang Regency vary, LPD UNM strives to instill a self-concept that is in line with each teacher's reasoning abilities to facilitate digital literacy in elementary schools in Pinrang Regency.

c) Knowledge

To clarify work standards and expectations, Spencer and Spencer in Busro (2018) argue that knowledge formed from information in the field is needed. To strengthen an individual's characteristics, a deep understanding of a specific field is necessary so that organizational goals can be achieved.

Based on observations and interviews, KKA training in Pinrang Regency plays an important role in providing theoretical understanding and practical concepts for realizing digital transformation in education, especially in Pinrang Regency. Skills are considered the weakest aspect. The ability to perform physical tasks (coding practice in class) is hampered by two factors: (1) lack of independent practice hours, and (2) network infrastructure constraints in the home school (Van Dijk, 2020). Maximizing productivity at the elementary school level in the scope of digital literacy requires schools to develop human resources in a targeted manner, both in terms of character and knowledge. The material prepared by LPD UNM during the training was tailored to the abilities of elementary school teachers. The teachers felt helped by the simple explanations and adjustments to the existing teaching materials.

In the context of policy implementation, excessive responses and enthusiasm from local governments and schools can also pose challenges, including policies on coding and KA learning. Support from local governments and schools is an important factor in the implementation of policies from the central government. However, if this enthusiasm is not balanced by appropriate and adequate support, policy implementation may not run optimally. Competence cannot stand alone without an enabling environment. In Human Capital theory, investment in individual skills will be wasted if not supported by physical capital (infrastructure). This finding reinforces the argument of Indra et al., (2024) that the digital divide in Indonesia is no longer a matter of device access, but rather the quality of connectivity that hinders productivity.

Learning from the experience of implementing the Merdeka Curriculum in 2022, misperceptions arose when local governments and schools interpreted the Merdeka Curriculum as a policy that must be implemented in schools without considering their readiness and providing adequate support for the implementation process. In this case, most local governments "instructed" schools in their areas to register and implement this new curriculum, without emphasizing the factors of readiness and efforts to provide support to schools. The high number of schools implementing this curriculum has resulted in suboptimal support for facilitating and assisting schools implementing this curriculum. This has resulted in only 34% of schools being able to implement learning and assessment practices in line with the curriculum in the "good" and "very good" categories.

CONCLUSIONS AND RECOMMENDATIONS

Computational skills for teachers and students need to be developed in order to improve their ability to develop IT-based teaching media and materials. Simply put, computational skills are the ability to apply technological capabilities and the skills to operate tools and computers in everyday life. These abilities include the ability to acquire, interpret, use, and communicate various technologies to solve problems in everyday life.

Qualitatively, the results of interviews and observations show that teachers perceive KKA learning as a new learning experience that is challenging, meaningful, and future-oriented. Many teachers are very enthusiastic about instilling computational thinking in their students. Given that the digitization of education is currently required for Indonesia to be internationally competitive.

When linked to Spencer and Spencer's theory in Jusriadi et al.,(2021), there are four indicators to show that an organization's human resources are capable of successfully implementing digitization in the field of education. Of these four indicators, several aspects still need optimization, namely:

1. Motives

As a result, elementary schools in Pinrang Regency are fully aware of the reasons for conducting development through coding and artificial intelligence training in their respective schools. However, the training provided is limited by time and opportunity because, at present, only schools that have Performance-Based Operational Funds (BOS Kinerja) can participate in the KKA Training

organized by the Ministry of Education and Culture and LPD UNM. Meanwhile, when viewed from a competency theory perspective, all parties must have a thorough understanding of coding and artificial intelligence so that curriculum development can be adapted to the needs of the times.

2. Traits

At the junior high school and high school/vocational school levels, it is highly likely that teachers qualified to teach coding and KA are already available, given that computer science is already part of the curriculum. The biggest challenge is at the elementary school level, especially public elementary schools, where teachers who teach daily lessons are classroom teachers with elementary school teaching qualifications. This makes training for all classroom teachers essential before implementing this subject. By making coding and AI compulsory subjects, the scale of training for teachers will be enormous. Based on research results, around 60% of elementary school teachers in Pinrang Regency are young teachers, so they are still able to adapt and accept coding and artificial intelligence learning.

3. Self-concept

Judging from the background of teachers at the elementary school level, they still do not meet Spencer and Spencer's criteria for self-concept. To be highly competent, human resources must be able to master and understand the learning, methods, and curriculum that are suitable for elementary school students. This makes KKA training helpful for teachers to understand and instill an essential self-concept before implementing this KKA subject.

4. Knowledge

Based on observations and interviews, KKA training activities in Pinrang Regency played a significant role in improving participants' understanding of the theories, concepts, and practices needed to drive digital transformation in the education sector, especially at the regional level. Efforts to optimize productivity at the elementary school level in the context of digital literacy require targeted human resource development in terms of both competence and knowledge. The materials prepared by LPD UNM during the training have been tailored to the abilities of elementary school teachers. The teachers also felt that they were helped because the material was delivered in a simple manner and tailored to their learning needs.

The challenges they faced, such as limited practice time and the complexity of programming logic, did not reduce their motivation to learn, but rather strengthened their engagement and determination to understand KKA concepts. This learning not only provided technical knowledge, but also shaped logical thinking skills, self-confidence, learning satisfaction, career orientation, and ethical responsibility towards technology. These findings confirm that the KKA subject has strategic potential in building technological character, career readiness, and 21st-century competencies in the vocational education environment. To optimize its implementation, adequate learning facilities and infrastructure are needed, especially additional practice time and increased

computer lab capacity so that students have more opportunities to experiment and develop coding and artificial intelligence skills independently. Teachers are also advised to develop project-based and industry collaboration learning models that are contextual so that students can relate KKA material to the real needs of the world of work, as well as participate in continuing training to enrich pedagogical approaches and deepen their understanding of digital ethics. In addition, further research can expand the scope of the population and variables studied, for example by comparing the perceptions of teachers and students regarding the implementation of KKA, or assessing the effectiveness of AI-based learning models in improving digital skills in various vocational schools. The results of this study can also be a reference for policymakers in strengthening national curriculum policies related to the integration of Coding and Artificial Intelligence subjects, taking into account school readiness, teacher capacity, and infrastructure support in various regions.

1. The Pinrang Regency Government, specifically the Pinrang Regency Education and Culture Office, must pay attention to the availability of teachers for coding and artificial intelligence subjects. It is necessary to conduct further training for teachers who have participated so that coding and artificial intelligence subjects have their own teachers.
2. Coding and KA learning ideally requires adequate ICT facilities and infrastructure (mainly computers and the internet). Currently, not all schools (especially elementary schools) have the ideal ICT facilities and infrastructure to serve all of their students. The implementation of coding and computer science as compulsory subjects will increase the burden on the government and educational institutions to provide supporting facilities and infrastructure, especially for schools that do not yet have them.
3. The Pinrang Regency Education and Culture Office must take strategic steps by changing the training model from one-off training to community-based learning assistance.

ADVANCED RESEARCH

This study has limitations because it only focuses on schools receiving BOS Kinerja (School Operational Assistance) and uses a qualitative approach that captures teacher readiness at a specific point in time. Therefore, further research is recommended to: (1) Expand the research subjects to include students to measure the impact of learning, (2) Use a longitudinal design to observe the effectiveness of continuous mentoring (Community of Practice), and (3) Develop an adaptive learning model that provides solutions to network infrastructure constraints in developing regions.

The proposed title for the next research project to further explore this topic is "Analysis of the digital divide in the readiness to implement the coding curriculum: a comparative study of schools receiving and not receiving BOS performance in Pinrang Regency." In terms of policy analysis, there is an evaluation of local government strategies in the equitable distribution of ICT infrastructure to support coding subjects in elementary schools.

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